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ABSTRACT

This compilation of marine science institutions, academic degrees, curricula, teaching and research facilities and teaching faculties, is based on information supplied by the institutions in response to questionnaires sent by the Committee on Marine Research, Education and Facilities. Programs are categorized in five main sections: Marine Science, Ocean Engineering, Maritime Officers, Fisheries, and Marine Technician. In the first section, only programs involving fifteen semester hours or more are included; institutions offering shorter courses are listed in an appendix. (FB)

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**ACADEMIC YEARS
1969-70 AND 1970-71**

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AND ENGINEERING DEVELOPMENT**

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Executive Secretary

ED0 41745

**UNIVERSITY CURRICULA
in the
MARINE SCIENCES AND RELATED FIELDS**

**ACADEMIC YEARS
1969-70 and 1970-71**

**Prepared by:
MARINE SCIENCES AFFAIRS STAFF
of the
OFFICE OF THE OCEANOGRAPHER OF THE NAVY
for the
NATIONAL COUNCIL ON MARINE RESOURCES
AND ENGINEERING DEVELOPMENT**

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TABLE OF CONTENTS

(Each institution is described by the type of degree program it offers: U=undergraduate and G=graduate. Where other types of programs are indicated, please consult the institutional listing for detailed information.)

| | <i>Page</i> |
|---|-------------|
| FOREWORD | vii |
| INTRODUCTION | ix |
| Explanatory Notes | ix |
| Typical Requirements for Admission to Graduate Study | ix |
| Financial Assistance Programs | xi |
| CURRICULA IN THE MARINE SCIENCES AND RELATED FIELDS | |
| Curricula in the Marine Sciences | 1 |
| University of Alaska, G | 3 |
| Alfred University, U | 6 |
| University of Arizona, G | 8 |
| University of California (Bodega Marine Laboratory), G | 10 |
| University of California (Davis), U, G | 11 |
| University of Chicago, G | 13 |
| Columbia University, G | 15 |
| University of Connecticut, G | 17 |
| Cornell University, U, G | 19 |
| University of Delaware, U, G | 21 |
| Duke University, G | 23 |
| Florida Atlantic University, G | 26 |
| Florida Institute of Technology, U, G | 28 |
| Florida State University, G | 30 |
| University of Florida, G | 32 |
| University of South Florida | 33 |
| University of West Florida, U | 35 |
| Fresno State College, U, G | 36 |
| George Washington University, U | 37 |
| University of Georgia, G | 38 |
| University of Guam, G | 41 |
| University of Hawaii, G | 42 |
| Humboldt State College, U, G | 46 |
| The Johns Hopkins University, G | 49 |
| Lehigh University, G | 51 |
| Long Island University (Mitchell Campus), G | 54 |
| Long Island University (Southampton), U | 56 |
| Louisiana State University (Baton Rouge), U, G | 58 |
| Louisiana State University (New Orleans), U, G | 62 |
| University of Maine, G | 63 |
| Massachusetts Institute of Technology, G | 65 |
| University of Massachusetts, G | 68 |
| University of Miami, G | 71 |
| University of Michigan, G | 75 |
| Naval Postgraduate School, G | 77 |
| University of New Hampshire, G | 79 |
| The City University of New York, U, G | 82 |
| Maritime College of the State University of New York, U | 85 |

| | <i>Page</i> |
|---|-------------|
| Curricula in the Marine Sciences—Continued | |
| New York University, U, G | 88 |
| North Carolina State University, G | 91 |
| University of North Carolina, G | 94 |
| University of North Dakota, G | 97 |
| Northeastern Illinois State University, U, G | 98 |
| Northeastern University, G | 100 |
| Nova University, G | 101 |
| Old Dominion College, G | 102 |
| Oregon State University, G | 104 |
| University of Oregon, U, G | 107 |
| University of the Pacific, G | 108 |
| University of Puerto Rico, G | 110 |
| University of Rhode Island, G | 112 |
| Rutgers University, U, G | 114 |
| Sacramento State College, U, G | 116 |
| Salem State College | 118 |
| San Diego State College, U, G | 119 |
| San Francisco State College, G | 123 |
| San Jose State College, U, G | 125 |
| Scripps Institution of Oceanography, G | 127 |
| University of Southern Mississippi, G | 131 |
| Stanford University (Hopkins Marine Station), G | 133 |
| Texas A&M University, G | 135 |
| Texas Christian University, G | 138 |
| University of Texas Marine Science Institute, G | 139 |
| United States Coast Guard Academy, U | 141 |
| United States Department of Agriculture Graduate School, Certificate | 142 |
| United States Naval Academy, U | 144 |
| Virginia Institute of Marine Sciences, G | 145 |
| Walla Walla College, G | 147 |
| University of Washington, U, G | 148 |
| Western Washington State College, U, G | 153 |
| University of Wisconsin, G | 155 |
| Woods Hole Oceanographic Institution, G | 159 |
| Other Institutions offering courses in Marine Science | 162 |
| Consortia in the Marine Sciences | 163 |
| Gulf Coast Research Laboratory, G | 165 |
| Gulf Universities Research Corporation, U, G | 166 |
| Marine Science Consortium of Pennsylvania Colleges and Universities, U, G | 167 |
| Moss Landing Marine Laboratories (California State Colleges), U, G | 170 |
| Curricula in Ocean Engineering | 173 |
| University of Alaska, G | 175 |
| University of California (Berkeley), G, Professional | 176 |
| Catholic University of America, U, G | 179 |
| University of Delaware, U, G | 182 |
| Florida Atlantic University, U | 184 |
| University of Florida, G | 186 |
| Gulf Coast Technical Institute, U | 187 |

| | <i>Page</i> |
|---|-------------|
| Curricula in Ocean Engineering—Continued | |
| University of Hawaii, G | 188 |
| University of Houston, G | 190 |
| Massachusetts Institute of Technology, U, G, Professional | 195 |
| University of Miami, U, G | 200 |
| University of Michigan, U, G, Professional | 202 |
| University of New Hampshire, G | 206 |
| Maritime College of the State University of New York, U | 208 |
| New York University, G | 210 |
| University of Rhode Island, G | 212 |
| Stevens Institute of Technology, G | 213 |
| Texas A&M University, G | 215 |
| University of Texas at Austin, G | 218 |
| University of Washington, U, G | 221 |
| Webb Institute of Naval Architecture, U, G | 223 |
| Other Institutions offering courses in Ocean Engineering | 224 |
| Curricula for Maritime Officers | 225 |
| California Maritime Academy, U | 227 |
| Maine Maritime Academy, U | 230 |
| Maritime College of the State University of New York, U | 232 |
| Texas Maritime Academy, U | 234 |
| United States Merchant Marine Academy, U | 236 |
| Curricula in Fisheries | 241 |
| Humboldt State College, U | 243 |
| University of North Dakota, U | 245 |
| Peninsula College, Associate | 247 |
| University of Rhode Island, Associate | 248 |
| University of Washington, U, G | 249 |
| Other Institutions offering courses in Fisheries | 253 |
| Curricula for Marine Technicians | 255 |
| Anne Arundel Community College, Associate | 257 |
| Cape Fear Technical Institute, Associate | 258 |
| Clatsop Community College, Associate | 260 |
| Fullerton Junior College, Associate | 261 |
| Highline Community College, Certificate | 262 |
| College of Marin, Associate | 263 |
| Santa Barbara City College, Associate | 265 |
| Suffolk County Community College, Associate | 267 |
| Texas A&M University, James Connally Institute | 268 |
| APPENDIX A | 271 |
| Institutions Offering Limited Ocean-oriented Courses | 273 |

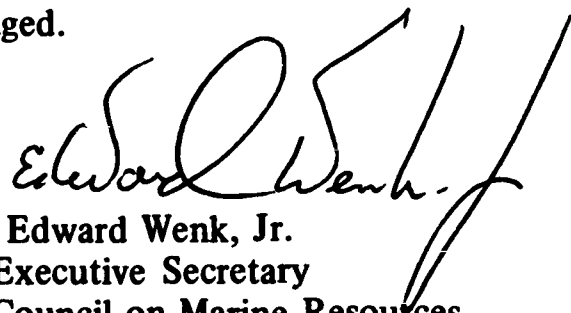
FOREWORD

In recent years, the Federal Government has assumed a major responsibility for the support of training and education of scientists, engineers, and technicians. This policy has significantly strengthened the marine sciences.

A principal function of the National Council on Marine Resources and Engineering Development is to coordinate Federal efforts in meeting long-range national goals in the marine sciences. Skilled manpower, in terms of both numbers and quality, is central to advancement in the marine sciences and achievement of these goals, for it is the individual talents which pace our progress.

This booklet provides information about training programs in the marine sciences and related fields. A wide diversity of curricula and several possible levels of training are described. Career opportunities in the marine field and the pathways to these careers are also indicated. The booklet is intended to aid in fostering full use of existing training facilities for students seeking marine science careers.

The Council is grateful for the cooperation of the many administrators and faculty members of the institutions who supplied the information for this Report. In particular, the counsel and advice of the National Academy of Sciences Committee on Oceanography and the National Academy of Engineering Committee on Ocean Engineering are gratefully acknowledged.



Edward Wenk, Jr.
Executive Secretary
National Council on Marine Resources
and Engineering Development

INTRODUCTION

This compilation of marine sciences institutions, academic degrees, curricula, teaching and research facilities and teaching faculties is based on information supplied by the institutions in response to questionnaires sent by the Committee on Marine Research, Education and Facilities. Only those institutions which responded to the questionnaire are included.

In the title of this document the term "marine sciences" refers to academic programs in oceanography, marine science and ocean engineering; these program areas place significant emphasis on the oceans. The distinction between "oceanography" and "marine science" reflects terms used by the institutions themselves. Generally, "oceanography" is considered a multi-disciplinary science whereas "marine science" refers to the marine branch of a particular scientific discipline—i.e., geology, chemistry, biology, etc. The titular term "related fields" refers to academic programs for training ships' officers and maritime engineers, naval architects, marine (science and engineering) technicians, and applied fisheries scientists and technicians.

The omission in this report of degrees in fields other than marine sciences does not in any way imply that a system of training which culminates in a marine sciences degree is superior to that which channels training through the more traditional scientific or engineering disciplines. Students with a primary interest in a classical discipline may wish to investigate its possibilities in relation to ocean-oriented work.

This booklet is not intended to provide a detailed description of each academic program nor is it to be considered a compilation of official college catalogs. Prospective students are strongly urged to obtain further information directly from those institutions in which they are interested.

Programs of the institutions which responded to the questionnaire have been placed in one or more of the five major sections of this report: Marine Science; Ocean Engineering; Maritime Officers; Fisheries; or Marine Technician. Institutions included in the marine science category offer at least fifteen semester hours or equivalent of primarily ocean-oriented courses. Those which offer less than fifteen semester hours are listed in Appendix A. Some 57 institutions have joined forces into four regional consortia, i.e., four partnerships which jointly support and use a common shore laboratory for research and educational purposes. These consortia programs are separately noted. All of the institutions which reported offering ocean engineering programs are included, as are those offering marine-related training programs in or for maritime operations, technicians and fisheries science and technology.

A standardized format has been followed in describing all of the programs. Institutions are listed alphabetically in each of the five program areas. Each institutional program is described in terms of its teaching and research facilities—laboratories, classrooms, ships, computers, etc.—and its academic programs and staff. Degrees offered and degree requirements of the institutions are described. Academic courses are listed by department name, course number and title, terms in which given and credits per course; departments and course descriptions are as used by the institution. Semesters in which the courses are offered are coded as: F-Fall, Sp-Spring, Su-Summer; W-Winter is used for those having a quarterly system. Credit hours are in accord with each institution's system, either semester or trimester/quarter. Three trimester hours equal two semester hours. Faculty are listed by department with the reported name of Chairman first. Each faculty member is listed with his rank reported at the time this pamphlet was prepared and with his or her highest academic degree earned. The name and address of the person to whom to direct inquiries is noted lastly for each institution.

TYPICAL REQUIREMENTS FOR ADMISSION TO GRADUATE STUDY

The formal requirements for admission to graduate study in marine science and ocean engineering vary greatly from one institution to another. However, basic minimum requirements can be identified as common prerequisites to admission.

Oceanography and Marine Science: The general requirements for admission to graduate schools are as follows:

- (1) A baccalaureate degree from an accredited college or university with a major in biology, chemistry, engineering, geology, mathematics, oceanography, or physics.
- (2) A cumulative undergraduate grade average of approximately "B" (or 3.00 on a 4.00 scale).
- (3) Mathematics through differential and integral calculus.
- (4) One year of chemistry, with laboratory.
- (5) One year of physics, with laboratory.
- (6) One semester of geology, with laboratory.
- (7) One semester of biology, with laboratory.
- (8) A broad background in the humanities.

It should be noted that these minimum requirements may be modified or waived for admission to a specific program. Students whose backgrounds do not include all of the required courses may in some cases be permitted to complete prerequisite courses, whether prior to or after admission to graduate study.

Satisfactory completion of additional courses such as the following is regarded as highly desirable for admission to study in particular disciplines: advanced calculus, differential equations, thermodynamics, organic chemistry, historical and structural geology, and vertebrate and invertebrate zoology. For admission to a specific discipline within the marine sciences the student should have an undergraduate major in the same or a closely related discipline, with appropriate minors. For instance, for admission to study in physical oceanography a student should have had a major in physics and a minor in mathematics or vice-versa.

Ocean Engineering: For students applying to graduate ocean engineering programs, requirements are not as clearly specified as those for the marine sciences. Broad general requirements can be identified as:

- (1) A baccalaureate degree in engineering or science from an accredited college or university.
- (2) A cumulative undergraduate grade average of approximately "B" (or 3.00 on a 4.00 scale).
- (3) Mathematics through differential equations.

Satisfactory completion of additional courses in mathematics, especially in advanced calculus, probability, and statistics, physical and life sciences, and economics is highly desirable.

Other requirements commonly include the taking of the Graduate Record Examinations and submission of recommendations from major professors. Deadlines for submission of applications and the schedules for fees vary greatly from institution to institution.

FINANCIAL ASSISTANCE PROGRAMS AVAILABLE FOR COLLEGE STUDENTS

Programs of Department of Health, Education and Welfare

National Defense Student Loan Program. Under this program students at all levels—from high school graduate to Ph.D. candidates—may be eligible for long-term, low-interest loans.

High school graduates who have been accepted for enrollment by participating colleges and universities, as well as graduate and professional students who are enrolled at least half time, and who need financial assistance are eligible for student loans.

An eligible undergraduate may borrow up to \$1,000 each academic year—to a total of \$5,000. An eligible graduate or professional student may borrow as much as \$2,500 each year to a maximum of \$10,000. Repayment need not begin until nine months after the student leaves college. Interest on the loan is three percent per year. Up to fifty percent of the loan may be cancelled or “forgiven” at the rate of ten percent for each year the borrower teaches in a public or other nonprofit elementary or secondary school or in an institution of higher education in the United States. The total loan may be cancelled at fifteen percent per year for teaching in certain schools in low-income areas.

College Work—Study Program. This program, supported by the Office of Education and administered by the participating colleges, provides students with an opportunity to earn part of their college expenses by working within the college or university or for a public or private non-profit organization. While classes are in session, a student may not work more than fifteen hours a week. During vacation periods, a student may work forty hours a week.

Guaranteed Loan Program. Students in attendance or accepted for admission in accredited institutions are eligible to borrow for college or vocational training expenses under this program. In general, depending upon the state in which they live, students may borrow up to \$1,500 per year. For students whose adjusted family income is less than \$15,000 a year, the Federal government will pay all interest charges (up to a maximum of seven percent) during the time they are in school and before the repayment period begins some nine to twelve months after studies are terminated.

Educational Opportunity Grants Program. This program, authorized by the Higher Education Act of 1965, provides for grants ranging from \$200 to \$1,000 to students of exceptional financial need for each of the four years of undergraduate study. Colleges participating in the program determine the student recipients of the grants and the amount required by the student. Any student in extreme financial need who has been accepted for admission at a participating college or who is already enrolled and in good standing is eligible to apply for a grant.

For further information on these four programs, write to the U.S. Office of Education, Division of Student Financial Assistance, Washington, D. C. 20202.

Programs of the Veterans Administration

Junior GI Bill. Under provisions of the Junior GI Bill and its recent amendments, educational allowances are paid to children (generally between the ages of 18-26) of veterans who were permanently or totally disabled, who died as a result of service in the U.S. Armed Forces, or who had peacetime service after the Spanish American War and prior to September 14, 1940.

Veterans Readjustment Benefits Act of 1966. This Act provides educational opportunities for qualified servicemen or women who have served in the Armed Forces on active duty for more than 180 days any part of which occurred after January 31, 1955, and for servicemen or women currently on active duty. Eligibility ceases at the end of 8 years after the date of the veterans' last release from active duty and assistance is available for a maximum of 36 months. Monthly payments vary with the type of training being sought and the number of dependents.

For further information on these two programs, write to any organization for veterans or your nearest Veterans Administration Office.

Reserve Officer Training Programs (ROTC). The Army, Navy, and Air Force conduct reserve officer training programs at selected colleges and universities. Financial assistance grants are available

to selected students. After completion of one of these programs, the student agrees to serve a stipulated period of time in the military service. Inquiries should be directed to the Chairman of the Department of Military Science of the institution in which the student plans to enroll or to the Department of Defense, Washington, D. C. 20301.

Other Federal Scholarship or Grant Awards. Some federal agencies provide financial support to students, both directly and indirectly. One such program is that of the Maritime Administration of the Department of Commerce which provides state maritime academies with \$600 per year for each student enrolled. This money is deposited in the student's account at the academy to be used for books, uniforms, etc.

In addition, Federal agencies support marine research programs at many universities. These programs provide financial support for graduate students in the form of assistantships, research fellowships, grants, and teaching stipends. Applications for such financial support should be made to the institution.

State Programs. A majority of the states and Puerto Rico sponsor financial assistance programs for undergraduate and first professional degree students. The amount and form of assistance as well as eligibility requirements vary among the states. The amount of aid often depends upon such factors as family income and other assets. To be eligible for assistance, students may be required to pass examinations, have superior academic records, or be enrolled in specific fields. Forms of assistance include loans, scholarships and grants-in-aid. Further information on State sponsored programs may be obtained from high school counselors and State departments of education. Some specific sources of financial assistance are noted in the *Need A Lift* publication listed below.

Nongovernmental Scholarships and Loans. Financial assistance programs maintained by local, state, and national units of social, civic, religious, and fraternal organizations provide loans and scholarships to outstanding and worthy students. In addition, many national scholarships are awarded through specific colleges to qualified students by large corporations and foundations.

The following publications provide information on other available assistance programs and may be obtained from the indicated offices.

"Federal Benefits for Veterans and Dependents" (VA Fact Sheet 1S-1)—Free of Charge
Veterans Benefits Office
Veterans Administration
Washington, D. C. 20420

"More Education, More Opportunity"—Free of Charge
U. S. Office of Education
Division of Student Financial Aid
Washington, D. C. 20202

"Need A Lift"—\$.25 per copy (pre-paid)
American Legion, Department S
P. O. Box 1055
Indianapolis, Indiana 46206

"Opportunities in Oceanography"—\$1.00 per copy
Smithsonian Press
Smithsonian Institution
Washington, D. C. 20560

"Scholarships for American Indian Youth"—Free of Charge
Bureau of Indian Affairs
Department of the Interior
Washington, D. C. 20240

"Financing a College Science Education"
Single copies may be obtained free of charge from the National Science Foundation,
Washington, D. C. 20550
Copies may be purchased in the quantity from the U. S. Government Printing Office,
Washington, D. C. 20402—\$.15 per copy

CURRICULA IN THE MARINE SCIENCES

UNIVERSITY OF ALASKA
College, Alaska

On the main University of Alaska campus at College, the Institute of Marine Science is currently housed within the Duckering Building. The Institute library employs a full-time librarian and contains over 5,000 volumes, together with a large reprint file relating principally to oceanography and ocean engineering. This latter collection is coded and computerized for rapid retrieval of specific information. In addition to this facility, the main University library and the specialized collections of other campus institutes and departments are readily available. The Institute also maintains an upgraded drafting and photographic unit.

The chemical oceanography section now has two specialized gas chromatographs for determining hydrocarbon pollutants in seawater. Within the same section, new equipment for work on trace inorganics in both freshwater and seawater has required the addition of specialized polarographic modules, and relocation has made it possible for both the biology-ecology and geology sections to acquire new equipment. In addition to the stable isotope analysis equipment, facilities are now available for gas, pigment, nutrient, carbon, nitrogen, and elemental tracer analyses in the biological laboratories. The marine geology laboratory is equipped with standard size analysis apparatus, petrographic microscopes, atomic absorption spectrophotometer, and a pressure flow system for diagenetic experiments.

The Douglas Marine Station, located near Juneau, now consists of two buildings with facilities for research, instructing, administration, equipment fabrication, and storage. A total of 10,000 sq. ft. of floor space includes laboratories for biology, chemistry, geochemistry, petrology, and sedimentology, with two general-purpose labs and a lecture room for summer field courses. Additional facilities available include a small library, darkroom, rock preparation lab, and a small walk-in cold storage unit for deep-sea sediment cores. Major research equipment recently added to the Marine Station includes a Perkin-Elmer 303 atomic absorption spectrophotometer and a Ziess Ultraphot microscope.

The station's Mt. Jumbo Building serves as a 20-man dormitory and also houses a machine shop, a plastics fabrication bench, and a wood-working shop. One of the principal missions of the Douglas Marine Station is the support of both the R/V ACONA and M/V MAYBESO.

In cooperation with the U. S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, the Institute of Marine Science has constructed a field station on the shore of Izembek Lagoon, an embayment of the Bering Sea 15 miles from the village of Cold Bay. The station, consisting of two quonset huts originally built during the military occupation of the area 25 years ago, comprises living quarters and a laboratory. These facilities can accommodate 3 or 4 investigators plus technicians. The equipment includes the essentials for routine chemical and biological work plus some specialized instruments for physiological studies.

For work in the Arctic Ocean and on the northern coast of Alaska, facilities are made available to the Institute by the Naval Arctic Research Laboratory at Point Barrow. The NARL provides all logistic support (including rig transportation) for work on the north coast and on the T-3 Ice Island. The Institute shares two hydro-huts with the physical oceanography group from the University of Washington.

The Institute operates the Research Vessel ACONA as its principal oceanographic platform. The R/V ACONA is an 80-foot steel vessel which carries a professional crew of six and a scientific party of nine. The ACONA is equipped with an oceanographic winch, a light hydrographic winch, two radars, three depth sounders, a precision depth recorder, three radio transceivers, loran, and other standard navigational equipment. The laboratory space requires most scientific equipment to be temporarily installed and removed each cruise. The ACONA has a speed of nine knots and an endurance of three weeks or 4500 miles.

The Institute also operates the 42-foot Motor Vessel MAYBESO—an eight-knot, wooden craft of basic fishing vessel design. The MAYBESO has a professional Captain and carries a four-man scientific party. The ship is equipped with a 400-meter hydrographic winch, two radio transceivers, and two depth sounders. Two 16-foot Boston Whalers and several miscellaneous skiffs are maintained at Douglas for daily use in the local area. Other vessels and aircraft are, on occasion, chartered for specific work required by Institute programs.

2/3

The purpose of the program in oceanography is to train oceanographers at the M.S. and Ph.D. level. The program is coordinated by an interdisciplinary committee of the University composed of selected staff members from the academic colleges and research institutes involved with ocean science.

The following degrees are offered in oceanography:

1. M.S. Degree in Biological Oceanography. (Thesis required)

Prerequisites—B.S. in the natural sciences, courses in calculus and physical chemistry.

Minimum credit requirements—30 graduate credits (9 of which may be thesis credits).

Course requirements—OCN 620, OCN 661, and OCN 613 or Biol. 652, and a minimum of six credits of additional course work to be selected by the student's committee.

2. M.S. Degree in Chemical Oceanography. (Thesis required)

Prerequisites—B.S. in the natural sciences, courses in calculus and physical chemistry.

Minimum credit requirements—30 graduate credits (9 of which may be thesis). Course requirements—OCN 620, OCN 663, OCN 650, or OCN 613, and a minimum of 6 credits of additional course work to be selected by the student's committee.

3. M.S. Degree in Geological Oceanography. (Thesis required)

Prerequisites—B.S. in the natural sciences, courses in calculus and physical chemistry.

Minimum credit requirements—30 graduate credits (9 of which may be thesis credits).

Course requirements—OCN 620, OCN 661 and OCN 650 or Biol. 652, and a minimum of 6 credits of additional course work to be selected by the student's committee.

4. M.S. Degree in Physical Oceanography. (Thesis required)

Prerequisites—B.S. in the natural sciences, courses in calculus and physical chemistry.

Minimum credit requirements—30 graduate credits (9 of which may be thesis credits).

Course requirements—OCN 620, OCN 661, and OCN 650 or OCN 613, and a minimum of 6 credits of additional course work to be selected by the student's committee.

5. Ph.D. Degree. There are no fixed course requirements nor is an M.S. degree required to obtain the Ph.D. degree. The degree is awarded for proven ability and scholarly attainment, the exact program to be determined by the student's advisory committee. A candidate for the Ph.D. degree in Marine Science will be expected to have had course work at least equivalent to that of the M.S. curriculum. Reading ability in one foreign language, appropriate to the student's discipline, is required.

The following courses are offered in conjunction with the above degrees:

| | | | |
|------------------|---|-------|---|
| OCN 613 | Marine Geology | Sp | 3 |
| OCN 620 | Introduction to Physical Oceanography | | |
| OCN 622 | Ocean Currents and Water Masses | | 3 |
| OCN 650 | Estuarine Dynamics | | |
| OCN 650 | Introduction to Biological Oceanography | | 3 |
| OCN 661 | Chemical Oceanography I | | 3 |
| OCN 663 | Chemical Oceanography II | | 3 |
| OCN 690 | Colloquium | | 3 |
| OCN 691-692 | Seminar | | 3 |
| OCN 693-694 | Special Topics | | 3 |
| OCN 697-698 | Thesis | | 3 |
| Biology | | | |
| Biol. 652 | Marine Ecology | | 3 |
| Chemistry | | | |
| Chem. 665 | Cellular Biochemistry | F, Sp | 3 |
| Geology | | | |
| Geol. 401 | Invertebrate Paleontology | F | 4 |
| Geol. 631 | Marine Geochemistry | F | 3 |
| Physics | | | |
| Phys. 361 | General Geophysics | F | 3 |
| Phys. 362 | General Geophysics | Sp | 3 |
| Phys. 460 | Geophysical Prospecting | F | 3 |

Physics—Continued

| | | | |
|----------------------------|-----------------------------------|-------|------|
| Phys. 465 | Meteorology | F, Sp | 3, 3 |
| Phys. 621 | Classical Mechanics | F | 3 |
| Phys. 625 | Hydrodynamics | F | 3 |
| Phys. 665 | Dynamic Meteorology | F, Sp | 3, 3 |
| Wildlife Management | | | |
| W.M. 325 | Scientific Sampling | F | 3 |
| W.M. 423 | Limnology | F | 3 |
| W.M. 424 | Ecology of Fishes | Sp | 3 |
| W.M. 426 | The Analysis of Linearized Models | Sp | 3 |
| W.M. 624 | Problems in Fisheries Management | Sp | 2 |

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Hood, Donald W., Ph.D., Director, Institute of Marine Science and Professor of Marine Science; Chemical Oceanography

Allen, Mary Belle, Ph.D., Professor of Microbiology and Marine Algology

Barsdate, Robert J., Ph.D., Associate Professor; Limnology and Chemical Oceanography

Behlke, Charles E., Ph.D., Dean of College of Mathematics, Physical Sciences and Engineering; Professor of Engineering

Benson, Carl S., Ph.D., Associate Professor of Geology and Geophysics

Berg, Eduard, Ph.D., Professor of Geophysics

Billaud, Vera A., Ph.D., Assistant Professor of Marine Science; Limnology

Burrell, David C., Ph.D., Assistant Professor of Marine Science; Geochemistry

Button, Don K., Ph.D., Associate Professor of Marine Science; Biochemistry

Forbes, Robert E., Ph.D., Chairman and Professor of Geology; Igneous Petrology

Goebel, Davis, Jr., Ph.D., Associate Professor of Electrical Engineering; Arctic Environmental Engineering Laboratory

Goering, John J., Ph.D., Professor of Marine Science; Biological Oceanography

Hoskin, Charles M., Ph.D., Assistant Professor of Geology; Sedimentology

Irving, Laurence, Ph.D., Advisory Scientific Director and Professor of Zoophysiology; Institute of Arctic Biology

Kinney, Patrick, J., Ph.D., Assistant Professor of Marine Science; Chemical Engineering

Matthews, J. Brian, Ph.D., Assistant Professor of Marine Science; Physical Oceanography

Mcroy, Peter C., M.S., Senior Research Assistant; Biological Oceanography

Miller, Keith L., Ph.D., Assistant Professor of Zoophysiology

Morrow, James E., Ph.D., Head, Department of Biological Science; Professor of Zoology

Natarajan, Kottayam V., Ph.D., Assistant Professor; Marine Microbiology

Nayudu, Y. R., Ph.D., Associate Professor of Marine Science; Geological Oceanography

Osterkamp, Thomas E., Ph.D., Assistant Professor of Physics

Peyton, Harold R., Ph.D., Professor of Engineering; Arctic Environmental Engineering Laboratory

Reeburgh, William S., Ph.D., Assistant Professor; Chemical Oceanography

Roberts, Thomas D., Ph.D., Associate Professor of Physics

Rosenberg, Donald H., M.S., Assistant Professor; Physical Oceanography

Sharma, Ghanshyam D., Ph.D., Assistant Professor; Marine Geology

Stone, David B., Ph.D., Research Associate Professor of Geophysics, Geophysical Institute

Van Hyning, Jack M., M.S., Associate Professor of Fisheries Biology

Wright, Frederick F., Ph.D., Assistant Professor; Marine Geology

To obtain further information, address all inquiries directly to:

Dr Donald W. Hood, Director
Institute of Marine Science
University of Alaska
College, Alaska

ALFRED UNIVERSITY Alfred, New York

The University offers marine and related science courses within the context of a program in Environmental Studies. The Geology, Chemistry, Physics, and Biology Departments are housed in modern buildings with adequate facilities for laboratory instruction and research. Faculty and students may also use the technical services and facilities of the College of Ceramics, a unit of the State University of New York and an integral part of Alfred University. The facilities, housed in Binns-Merrill Hall, include special laboratories for chemistry, petrography, spectroscopy, electron microscopy, X-rays, and mass spectrometry. A Computer Center equipped with an IBM 1800 real-time computer is also available for instruction and research.

Field programs are conducted on nearby Seneca Lake which has a maximum depth of over 600' and is ice-free throughout the year. The University charts the LAKE DIVER IV, a 44-ton former Coast Guard buoy tender. The vessel has an adequate power source, winches for handling heavy equipment, a fathometer, and ship-to-shore communication facilities. A radar unit will be added in the near future. Scientific equipment includes: dredges, corers, plankton collecting devices, a television camera, Nansen bottles, temperature recording apparatus, and an on-board wet-chemical analytical laboratory.

The University offers the B.A. degree through its College of Liberal Arts. The Program represents an undergraduate interdisciplinary approach to regional problems of the human community and is designed to give students an opportunity to participate in the application of basic knowledge to problems of man and his environment.

In addition to the standard requirements for a science or social science major, the Program requires course work in Sociology, Physical Geography, Aquatic Science and Ecology. The selection of electives appropriate to the development of an independent research project to be completed in the senior year is also encouraged. A required senior interdepartmental seminar considers topics of broad interest to the area of environmental study and provides an opportunity for the exchange of ideas between students and faculty working on specific problems. The student who completes the Environmental Studies Program will receive certification on his academic record.

The following courses are offered in conjunction with the above program:

Department of Biology

| | | | |
|---------|---|-------|-----------------------------|
| 350 | Limnological Methods | F | 3 |
| 394 | Ecology | Sp | 4 |
| 491-492 | Seminar (Interdepartmental) | F, Sp | 1, 1 |
| 550 | Research (Limited to Seniors and Graduate Students) | F, Sp | credit hours to be arranged |

Department of Chemistry

| | | | |
|------------|--|-------|-----------------------------|
| 211 | Inorganic Chemistry of Aqueous Solutions | F | 4 |
| 450 or 550 | Independent Study | F, Sp | credit hours to be arranged |

Department of Geology

| | | | |
|-----|---|-------|-----|
| 327 | Physical Geography | F | 3 |
| 332 | Oceanography | Sp | 3 |
| 450 | Independent Research (Limited to Seniors) | F, Sp | 1-3 |

The instructional staff for the courses listed above consists of the following:

Department of Geology

Sass, Daniel B., Ph.D., Chairman and Professor of Geology

Department of Biology

Finlay, Peter S., Ph.D., Chairman and Professor of Biology

Rough, Gaylord E., Ph.D., Professor of Biology

Barton, J. D., Jr., Ph.D., Professor of Biology

Gerace, Donald T., M.S., Lecturer in Science Education

Department of Chemistry

Sands, Richard D., Ph.D., Associate Professor of Chemistry

To obtain further information, address all inquiries directly to:

Dr. J. D. Barton, Jr.

Provost and Vice President for Academic Affairs

Alfred University

P. O. Box 1285

Alfred, New York 14802

THE UNIVERSITY OF ARIZONA

Tucson, Arizona

An international cooperative marine sciences program between the University of Arizona and the Universidad de Sonora in Hermosillo was initiated in 1958; and programs in field research and training have expanded since that time. The present Marine Sciences program and facilities are located in the Biological Sciences Building on the Campus in Tucson and extensive new quarters are currently under construction. The Puerto Peñasco Marine Research Station is located one and one-half miles southeast of the small fishing port of Puerto Peñasco, Sonora, Mexico. The Station was built on 49 acres of land facing on the Gulf of California. It is located 225 road miles southwest of Tucson, about an hour by air from either Tucson or Hermosillo. The 750 sq. ft. Laboratory has one large room equipped with two chemical benches and shelving, and an office, library and storeroom. Shielded sea water tables and sorting areas are on three sides of the Laboratory. These are fed by a salt water system drawing naturally filtered sea water from a nearby beach well. Plans call for converting a second building into a research laboratory. Within a short distance of the Station, there is a great diversity of marine ecological environments. The municipal port area has deep water docking facilities. A 23-foot LONE STAR cabin cruiser, with trailer, is assigned to the Station. It is equipped with wet and dry specimen laboratory facilities and the basic collecting gear.

The following degrees are offered in the indicated basic sciences:

1. Ph.D. in Biology, Botany or Zoology, Department of Biological Sciences. Students majoring in Marine Biology in the department may elect to take the doctorate degree in either Biology, Botany or Zoology. In addition to the major, a suitable minor area must be selected. An approved dissertation problem in the marine sciences is required. In addition to an individually planned graduate study program, the student must (1) obtain proficiency in elementary statistics applied to data from biological systems, and (2) demonstrate proficiency in two foreign languages or high proficiency in one, or demonstrate proficiency in one foreign language and complete an approved formal course in statistics or computer techniques.

2. M.S. in Biology, Botany or Zoology, Department of Biological Sciences. Students majoring in Marine Biology in the department may elect to take the master's degree in either Biology, Botany or Zoology. An approved thesis problem in the marine sciences is required. The student must satisfactorily complete 30 graduate credit units in an approved graduate study program.

Courses in the marine sciences are offered during the regular year at the main campus by the Departments of Biological Sciences and Hydrology and Water Resources. The Department of Biological Sciences also offers both regular summer courses and special field research instruction at the Puerto Peñasco Marine Research Station.

Department of Biological Sciences:

| | | | |
|------|------------------------------------|---------|-----|
| 240 | Oceanography | Sp | 2 |
| 240L | Oceanography Laboratory | Sp | 2 |
| 242 | Marine Ecology | Su | 5 |
| 243 | Marine Invertebrate Zoology | Su | 5 |
| 266 | Comparative Physiology | F | 4 |
| 275 | Phycology | F | 4 |
| 276 | Marine Algae | Sp | 3 |
| 280 | Invertebrate Zoology | Sp | 4 |
| 282 | Ichthyology | Sp | 4 |
| 340 | Advanced Studies in Marine Biology | F or Sp | 2 |
| 399 | Seminar | F, Sp | 1-3 |
| 400 | Research | F, Sp | 1-8 |
| 410 | Thesis | F, Sp | 1-8 |
| 420 | Dissertation | F, Sp | 1-9 |

Department of Hydrology and Water Resources:

| | | | |
|-----|---|----|---|
| 281 | Physical Oceanology and Limnology for Hydrologists | Sp | 2 |
|-----|---|----|---|

The instructional staff for the courses listed above consists of the following:

Atmospheric Physics Institute

Sellers, William D., Ph.D., Professor of Meteorology

Department of Biological Sciences

Baldwin, Howard A., M.S., Research Associate in Biological Sciences

Carlson, John S., Ph.D., Assistant Professor of Biological Sciences

Hoshaw, Robert W., Ph.D., Professor of Biological Sciences

Mead, Albert R., Ph.D., Professor of Biological Sciences

Pickens, Peter E., Ph.D., Associate Professor of Biological Sciences

Russell, Stephen M., Ph.D., Associate Professor of Biological Sciences

Thomson, Donald A., Ph.D., Associate Professor of Biological Sciences

Environmental Research Laboratory

Hodges, Carl N., B.S., Supervisor of the Environmental Research Laboratory

Department of Geology

Schreiber, Joseph F., Ph.D., Professor of Geology

Department of Hydrology and Water Resources

Simpson, Eugene S., Ph.D., Professor of Hydrology and Water Resources

Department of Nuclear Engineering

Post, Roy G., Ph.D., Professor of Nuclear Engineering

Department of Systems Engineering

Browning, Gen. Samuel R., M.S., Professor of Systems Engineering

To obtain further information, address all inquiries directly to:

Dr. Albert R. Mead

Chairman, Marine Sciences Committee

University of Arizona

Tucson, Arizona 85721

**BODEGA MARINE LABORATORY
(UNIVERSITY OF CALIFORNIA)
Bodega Bay, California**

The Bodega Marine Laboratory is a research and teaching facility of the University of California. The Laboratory is situated on a 326-acre biological refuge located on the outer coast of Bodega Head; the property includes more than a mile of rocky shoreline, short stretches of sandy beach, and mixed mud and sand flats in Bodega Harbor. The laboratory building houses 25 modern research laboratories and 2 teaching laboratories. Equipment and facilities are available for work in biochemistry, physiology, developmental biology, microbiology, ecology, botany, zoology, and marine geology. The laboratory is provided with running sea water which is pumped directly from the ocean; there is a large aquarium room which contains numerous aquaria and tanks which range in size up to a capacity of 1000 gallons. A 31-foot diesel powered cruiser and a 22-foot bartender are available for work in the open sea; other, smaller, boats are available for work in the harbor.

The degrees of Master of Arts and Doctor of Philosophy in Botany and in Zoology are offered by the Botany and Zoology Departments on the Berkeley and Davis Campuses for research carried out at the Bodega Marine Laboratory. Courses at the Laboratory are credited toward degree work on these and other campuses of the University of California.

The following courses are offered in 1969 in conjunction with the above programs:

Courses taught at BML are offered under the aegis of departments located on campuses of the University.

UNDERGRADUATE

Botany Department, Berkeley Campus

104 Marine Botany

Geology Department, Davis Campus

S119 Marine Geology and Paleoecology of the Continental Shelf

198 Directed Group Study

199 Special Study for Advanced Undergraduates

Zoology Department, Berkeley Campus

157 Biology of Marine Invertebrates

GRADUATE

Geology Department, Davis Campus

S219 Special Studies in Marine Geology and Paleoecology

298 Group Study

299 Research

Zoology Department, Berkeley Campus

257 Advanced Biology of Marine Invertebrates

The instructional staff (1968) for the courses listed above consists of the following:

Ghiselin, Michael T., Ph.D., Assistant Professor of Zoology, University of California, Berkeley

Holland, Nicholas C., Ph.D., Assistant Professor of Marine Biology, University of California,

San Diego

Lipps, Jere H., Ph.D., Assistant Professor of Geology, University of California, Davis

Stasek, Charles R., Ph.D., Associate Professor of Zoology, Florida State University

Todd, Thomas W., Ph.D., Assistant Professor of Geology, University of California, Davis

West, John A., Ph.D., Assistant Professor of Botany, University of California, Berkeley

Valentine, James W., Ph.D., Associate Professor of Geology, University of California, Davis

To obtain further information, address all inquiries directly to:

Dr. Cadet Hand, Director

Bodega Marine Laboratory

P. O. Box 247

Bodega Bay, California 94923

UNIVERSITY OF CALIFORNIA, DAVIS
Davis, California

The marine sciences program on the Davis campus provides instruction and research opportunities in geological and biological oceanography. This program is offered in the Departments of Geology and Zoology, and the Institute of Ecology. Each of these instructional units provides modern well-equipped laboratory, instrumental, and shop facilities, including transmission and scanning electron microscopes, an electron microprobe, controlled environment rooms, sea water systems, etc. The Zoology Department and Institute of Ecology have recently moved into new buildings, and the Geology Department will move into a new building in 1970.

In addition to the facilities on the Davis campus, the marine sciences program is supported by the Bodega Marine Laboratory, Bodega Bay, California, which is described earlier in this section.

The following degrees are offered in the basic sciences:

1. Department of Geology: B.A., B.S., M.S., Ph.D. in Geology with specialization in marine science.

2. Department of Zoology: B.A., B.S., M.A., Ph.D. in Zoology.

3. Ecology Graduate Group: M.S., Ph.D. in Ecology with specialization in marine science.

The Departments of Geology and Zoology, and the Institute of Ecology offer advanced degrees with thesis research in marine geology, ecology, paleoecology, or sedimentary petrology. An integrated, full-time program will be offered during the regular school year by the Departments of Geology and Zoology. A special curriculum in "Animal evolution in marine ecosystems" will be provided for advanced undergraduates and graduates by the Geology and Zoology Departments during the spring quarters.

The following courses are offered in conjunction with the above programs:

Ecology

201A

201B

201C

Geology

105

Structural Geology

4

107

Paleobiology

5

111A

Paleobiology of Invertebrata

4

111B

Paleobiology of Protista

4

S119

Marine Geology and Paleobiology

9

126

Sedimentation

4

153

Studies in Geomorphology

3

190

Seminar in Geology

1

198

Directed Group Study

1-5

199

Special Study for Advanced Undergraduates

1-4

213

Geomorphology

3

216

Tectonics

3

S219

Research in Marine Geology & Paleobiology

6-9

257

Sedimentary Petrology: Terrigenous Rocks

4

258

Sedimentary Petrology: Carbonate Rocks

4

260

Paleontology

3

261

Paleoecology

3

262

Paleosystematics

3

263

Functional Morphology of Fossil Invertebrates

4

290

Seminar in Geology

1

298

Group Study

2

299

Research

1-6

Zoology

| | | |
|------|---|-----|
| 112 | Invertebrate Zoology | 5 |
| 114 | Invertebrate Physiological Ecology | 5 |
| 116 | Principles of Animal Resource Management | 5 |
| 125 | Animal Ecology | 3 |
| 125L | Field Ecology | 3 |
| 140 | Limnology | 4 |
| 140L | Limnology Laboratory | 3 |
| 142 | Invertebrate Physiology | 4 |
| 142L | Invertebrate Physiology Laboratory | 3 |
| 144 | Oceanography | 4 |
| 147 | Zoogeography | 4 |
| 148 | Animal Phylogeny and Evolution | 5 |
| 160 | Invertebrate Neurophysiology | 5 |
| 197 | Senior Colloquium in Zoology | 2 |
| 199 | Special Study for Advance Undergraduates | 1-5 |
| 202 | Biomathematics | 6 |
| 222 | Mathematical Models of Ecosystems | 4 |
| 223 | Seminar in Fisheries Management | 4 |
| 293 | Seminar in Invertebrate Zoology | 2 |
| 294 | Seminar in Animal Ecology | 3 |
| 295 | Seminar in Limnology | 3 |
| 297 | Seminar in Systematic Zoology & Evolution | 2 |
| 298 | Group Study | 1-5 |
| 299 | Research | 1-9 |

The instructional staff for the courses listed above consists of the following:

Department of Geology

Chipping, David H., M.S., Lecturer of Geology
Cowen, Richard, Ph.D., Assistant Professor of Geology
Higgins, Charles G., Ph.D., Professor of Geology
Lipps, Jere H., Ph.D., Assistant Professor of Geology
Moores, Eldridge M., Ph.D., Assistant Professor of Geology
Valentine, James W., Ph.D., Professor of Geology

Department of Zoology

Goldman, Charles R., Ph.D., Professor of Zoology
Hamner, William M., III, Ph.D., Assistant Professor of Zoology
Kammer, Ann E., Ph.D., Assistant Professor of Zoology
Miller, Milton A., Ph.D., Professor of Zoology
Rudd, Robert L., Ph.D., Associate Professor of Zoology
Salt, George W., Ph.D., Associate Professor of Zoology
Watt, Kenneth F. F., Ph.D., Professor of Zoology

To obtain further information, address all inquiries directly to:

Geology and Ecology: Dr. Jere H. Lipps
Department of Geology
University of California
Davis, California 95616

Zoology: Graduate Advisor
Department of Zoology
University of California
Davis, California 95616

THE UNIVERSITY OF CHICAGO

Chicago, Illinois

The Marine Sciences Program at the University of Chicago is within the Department of the Geophysical Sciences, located in the Henry Hinds Laboratory for the Geophysical Sciences. The central core of the building consists almost entirely of research laboratories and associated shop facilities. Among these are several wave tank laboratories which include wave tanks up to eighty feet long used for beach studies, random wave and interaction studies, and internal wave investigations. Other facilities include a flume, wind tunnel, paleoecology laboratory, sedimentology laboratory, geochemistry laboratories, an electron microprobe, and x-ray diffraction equipment. The Hydrodynamics Laboratory occupies the sub-basement. The University Computing Center is close by. Field facilities are available through cooperation with the Woods Hole Oceanographic Institution and the Pacific Marine Station of the University of the Pacific.

Degrees are not offered specifically in the Marine Sciences or Oceanography. The M.S. and Ph.D. degrees in the Geophysical Sciences are offered with specialization in the areas included within the Marine Sciences.

1. Master of Science (Geophysical Sciences). The requirements for this degree are:

- a. A program of study approved by the Departmental Counsellor, normally consisting of nine graduate courses: at least three basic-science courses, at least three geophysical science courses, and at least one research course. Courses in basic-science may be taken in or outside the department.
- b. An average grade of not lower than B and no grade lower than C in the courses offered for the degree.
- c. A pass in a reading comprehension examination in German or Russian.

2. Doctor of Philosophy (Geophysical Sciences). The requirements are:

- a. A program of study approved by the student's Advisory Committee, normally consisting of at least nine graduate courses.
- b. A pass in a reading comprehension examination in two modern foreign languages, one of which must be Russian or German.
- c. A preliminary examination consisting of a written part covering fields that the student has selected for his program of study, followed by an oral part based on the student's proposal for a dissertation topic that he has submitted as a research prospectus.
- d. A dissertation by the candidate on the results of independent research in the geophysical sciences, followed by an oral final examination on the dissertation and the field of specialization.

A more detailed statement of the program for the Ph.D. degree is available upon request from the Departmental Counsellor.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES:

| | | | |
|-----|--|----|---|
| 131 | Introduction to the Geophysical Sciences I | F | 3 |
| 132 | Introduction to the Geophysical Sciences II | W | 3 |
| 133 | Introduction to the Geophysical Sciences III | Sp | 3 |
| 200 | Introduction to Fluid Mechanics | F | 3 |
| 201 | Fluid Mechanics I | F | 3 |
| 202 | Fluid Mechanics II | W | 3 |
| 203 | Fluid Mechanics III | Sp | 3 |
| 207 | Physiochemical Principles | F | 3 |
| 234 | Paleontology | F | 3 |
| 280 | Introduction to Geophysical Dynamics | W | 3 |
| 281 | Waves in the Atmosphere | W | 3 |
| 282 | Waves in the Ocean | W | 3 |

GRADUATE COURSES:

| | | | |
|-----|----------------------------------|--------|---|
| 301 | Boundary-Layer Theory | F* | 3 |
| 302 | Hydrodynamic Stability | W* | 3 |
| 303 | Turbulence | Sp* | 3 |
| 304 | Dynamics of Rotating Fluids | Sp* | 3 |
| 305 | Experimental Hydrodynamics | W* | 3 |
| 348 | Shallow-Water Oceanography | W, Sp* | 3 |
| 361 | Atmospheric Convection | F | 3 |
| 362 | Numerical Weather Prediction | Sp | 3 |
| 363 | Dynamics of Planetary Atmosphere | Sp | 3 |
| 381 | Tides of the Geosphere | F | 3 |
| 385 | Seminar: Sediment Transport I | F | 3 |

RESEARCH COURSES (Offered Fall, Winter, Spring, Summer):

| | |
|-----|---|
| 404 | Research in Fluid Mechanics |
| 441 | Research in Dynamical Oceanography |
| 461 | Research in Dynamical Prediction |
| 462 | Research in Hydrodynamical Models |
| 463 | Research in Experimental Hydrodynamic Stability |
| 464 | Research in Convection |
| 466 | Research in Theoretical Fluid Mechanics |
| 481 | Research in Marine Geophysics |

The instructional staff for the courses listed above consists of the following:

Department of the Geophysical Sciences

Clayton, Robert N., Ph.D., Professor of Geochemistry
Fultz, Dave, Ph.D., Professor of Meteorology and Student Counsellor
Johnson, Ralph G., Ph.D., Professor of Paleontology
Kuo, Hsiao-Lan, Ph.D., Professor of Meteorology
Lindzen, Richard S., Ph.D., Associate Professor of Meteorology
McGoldrick, Lawrence F., Ph.D., Assistant Professor of Fluid Mechanics
Miller, Robert L., Ph.D., Professor of Marine Geophysics and Geology
Pedlosky, Joseph, Ph.D., Associate Professor of Meteorology
Platzman, George W., Ph.D., Professor of Meteorology
Reid, William H., Ph.D., Professor of Applied Mathematics
Witting, James M., Ph.D., Assistant Professor of Hydrodynamics

To obtain further information, address all inquiries directly to:

Dr. Julian R. Goldsmith
Department of the Geophysical Sciences
The University of Chicago
Chicago, Illinois 60637

*Offered in alternate years

COLUMBIA UNIVERSITY
New York, New York

Graduate students in marine sciences at Columbia University normally enroll in the Department of Geology, those in marine biology enroll in the Department of Biological Sciences. There is no separate Department of Oceanography. Students follow a program of study based on the varied courses offered within these departments. The major research facilities for the marine sciences (along with an extensive oceanographic library and computer facilities) are located at the Lamont-Dougherty Geological Observatory campus of Columbia University in Palisades, New York. At Lamont, research is conducted in physical, chemical, geophysical and biological oceanography as well as solid earth geophysics, geochemistry and meteorology.

The students have access to the material collected on numerous deep-sea expeditions of Lamont ships; among this data is the largest collection of deep-sea cores in the world. The Lamont-Dougherty Observatory carries out oceanographic work aboard the 202-foot 734-ton, 3-masted schooner, VEMA, and the 208-foot 1370-ton AGOR-3, ROBERT D. CONRAD. In addition, polar oceanographic programs are conducted aboard the U.S.N.S. ELTANIN in conjunction with the Office of Antarctic Programs of the National Science Foundation, and the laboratories located on drifting ice in the Arctic Ocean. Columbia University operates a geophysical field station in Bermuda which specializes in the underwater propagation of sound. They conduct field research in the North Atlantic and the Caribbean aboard the vessel, SIR HORACE LAMB.

The degrees of **Master of Arts** and **Doctor of Philosophy** are offered.

The following basic courses are offered by the departments indicated. The exact curriculum to be followed by each student depends on his field of specialization and is decided upon by the student and his advisor.

Geology Department

| | |
|-------------|---|
| *G6881x | Chemical Equilibria in Geologic Systems |
| †W4928y | Submarine Geology |
| W4941x | Introduction to Geophysics |
| G6927x | Oceanography |
| G6928 | Advanced Submarine Geology |
| G6946y | Elastic Waves |
| G8928y | Dynamical Oceanography |
| G8943x | General Geophysics |
| G9929x or y | Seminar in Physical Oceanography |
| W4226x | Experimental Marine Sedimentology |
| G6223y | Principles of Sedimentation |
| G6945x | Geo-Dynamics |

Physics Department

| | |
|---------|---------------------------------|
| G4003x | Lagrangian Mechanics |
| G6019x | Mathematical Methods in Physics |
| G6051x— | Advanced Laboratory Work |
| G6052y | |

School of Engineering and Applied Science

| | |
|-------------|-----------------------------------|
| E4201x or y | Partial Differential Equations, I |
| E4204x or y | Functions of a Complex Variable |
| E4261x | Basic Continuum Fluid Mechanics |
| E4262y | Statistical Theory of Turbulence |
| E6365y | Hydrodynamics |
| E6367x | Hydrodynamic Stability |

*indicates autumn term

†indicates spring term

Chemistry Department

*G4131x Introduction to Chemical Physics
†G4133y Chemical and Statistical Thermodynamics
G4134y Radiochemistry

Department of Biological Sciences

G6071x Marine Microbiology
G6074y Biology of Plankton

The instructional staff for the courses listed above consists of the following:

Alsop, Leonard E., Adjunct Associate Professor
Anderson, Orson L., Professor
Be, Allan W. H., Senior Research Associate, L.G.O.
Broecker, Wallace S., Professor
Donn, William L., Senior Research Associate (Visiting), L.G.O.
Dorman, H. James, Lecturer and Assistant Director, L.G.O.
Drake, Charles L., Professor
Ewing, W. Maurice, Professor and Director, L.G.O.
Garlick, G. Donald, Assistant Professor
Gast, Paul, Professor
Gordon, Arnold L., Assistant Professor
Hays, James D., Assistant Professor
Hunkins, Kenneth L., Lecturer and Senior Research Associate, L.G.O.
Isacks, Bryan L., Adjunct Assistant Professor
Kuo, John T., Associate Professor
McCamy, Keith, Adjunct Lecturer
Nafe, John E., Professor
Oliver, Jack E., Professor
Roels, Oswald, Senior Research Associate, L.G.O.
Sykes, Lynn, Assistant Professor
Talwani, Manik, Associate Professor
Worzel, J. Lamar, Professor and Associate Director, L.G.O.

To obtain further information, address all inquiries directly to:

Professor John E. Nafe
Educational Coordinator
Geology Department
Columbia University
New York, New York 10027

*indicates autumn term

†indicates spring term

UNIVERSITY OF CONNECTICUT Storrs, Connecticut

Marine Research Laboratory, Noank, Connecticut

The Laboratory is located at the mouth of the Mystic River (west bank). The main laboratory building is a two-story brick structure and has a concrete deck leading to a T-shaped dock, 125 feet long and 50 feet parallel to the channel. The building contains eight laboratory rooms, darkroom, histological technique room, balance room, library, shop and storerooms. Two additional laboratory rooms are equipped for microbiology and ecology. All basic utilities, including salt water, are supplied to all laboratories. The laboratories contain chemical, radiobiological, climatological and ecological equipment. An electronics shop, complete scuba equipment and some living facilities are in two wooden buildings. Research is primarily in biological oceanography. A 65-foot former T-boat, a 28-foot and a 44-foot cabin cruiser, one 25-foot open launch and several skiffs are available for research work. An assortment of biological and hydrographic collecting gear is used.

Marine Sciences Institute, Avery Point, Groton, Connecticut

The Institute is newly formed, initiating a program in marine sciences in 1968. The Institute is located on the east bank of the mouth of the Thames River at the former Coast Guard Training Center. Two concrete buildings with approximately 48,000 square feet of space are being remodeled for research in physical and chemical oceanography, marine geology and geophysics, atmospheric science, and ocean engineering. The buildings will provide laboratory and office space for Institute staff and students. Two large concrete piers are available near the buildings, which are also being made ready for Institute use. The Institute has two cabin cruisers, one 40 feet long and one 36 feet long, a 24-foot open launch, and is obtaining both a 65-foot steel-hulled T-boat and a skiff. In its first year of operation, the Institute has been making investigations in marine geology and geophysics and in physical oceanography.

Since the Marine Research Laboratory has been doing primarily biological research, the Institute is initiating primarily non-biological programs. The two facilities are seven miles apart and will continue to operate at their present locations, with the Laboratory becoming a division of the Institute on July 1, 1969.

The Master of Science and Doctor of Philosophy degrees are offered in various departments of the University with specialization in marine science.

The following courses are offered by the departments indicated in conjunction with the above programs. 200 course numbers are for upper division undergraduate credit; 300 course numbers for graduate credit.

Biological Sciences Group

| | | | |
|-----|-------------------------------|-----------|-----|
| 265 | Marine Microbiology | F | 3 |
| 281 | Introductory Phycology | Sp | 4 |
| 300 | Special Problems | F &/or Sp | 1-4 |
| 303 | Special Problems | F &/or Sp | 1-4 |
| 310 | Seminar | F &/or Sp | 1 |
| 311 | Seminar | F &/or Sp | 1 |
| 317 | Marine Ecology | F | 3 |
| 319 | Marine Ichthyology | F | 3 |
| 320 | Advanced Invertebrate Zoology | So | 4 |
| 381 | Advanced Phycology | F | 3 |
| 389 | Pathobiology of Invertebrates | F | 3 |
| 498 | Special Readings | | 0 |

Civil Engineering

| | | | |
|-----|-------------------|-------|---|
| 394 | Water Pollution | F, Sp | 3 |
| 395 | Water Pollution | | 3 |
| 401 | Ocean Engineering | | 3 |

Geology and Geography

| | | | |
|-----|--------------------------------|----|-----|
| 217 | Sedimentation | F | 3 |
| 263 | Meteorology and Climatology | F | 3 |
| 264 | Physics of the Earth | F | 3 |
| 265 | Methods in Regional Geophysics | Sp | 3 |
| 272 | Physical Oceanography I | F | 3 |
| 310 | Micropaleontology | F | 4 |
| 370 | Physical Oceanography II | Sp | 3 |
| 371 | Chemical Oceanography | Sp | 3 |
| 400 | Special Topics in Geophysics | | 1-4 |
| 410 | Special Topics on Geophysics | | 1-4 |

The instructional staff for the courses listed above consists of the following:

Biological Sciences Group**Bacteriology**

Buck, John D., Ph.D., Assistant Professor of Biology

Botany

Trainor, Francis Rice, Ph.D., Professor of Biology

Page, Joanna (Ziegler), Ph.D., Assistant Professor of Biology

Zoology

Rankin, John S., Jr., Ph.D., Professor of Biology and Director, Marine Research Laboratory

Feng, Sung Yen, Ph.D., Associate Professor of Biology

Franz, David R., Ph.D., Assistant Professor of Biology

Lund, William A., Jr., Ph.D., Assistant Professor of Biology

Geology and Geography

Dehlinger, Peter, Ph.D., Director, Marine Sciences Institute and Professor of Geology

Frankel, Larry, Ph.D., Professor of Geology

Nalwalk, Andrew J., Ph.D., Assistant Professor of Geology

Rumney, George R., Ph.D., Associate Professor of Geography

Thomas, Hugo, Ph.D., Assistant Professor of Geology

Civil Engineering

Widmer, Wilbur, J., S.M., Associate Professor of Civil Engineering

To obtain further information, address all inquiries directly to:

A. Marine Sciences (except biology)

Dr. Peter Dehlinger, Director

Institute of Marine Sciences

University of Connecticut

Southeastern Branch

Groton, Connecticut 06340

B. Biological Oceanography

Dr. John S. Rankin, Jr., Director

University of Connecticut

Marine Research Laboratory

Noank, Connecticut 06340

CORNELL UNIVERSITY
Ithaca, New York

Shoreside laboratory and boat facilities are available at Cayuga Lake. On the Cornell campus special facilities for marine research, such as oceanographic and limnological laboratories, constant temperature rooms, aquarium rooms and experimental fish rearing ponds, are backed up by extensive shop and laboratory facilities, and one of the larger University library systems (over 3 million volumes), with exceptionally rich holdings in marine subjects.

Since 1966 Cornell has offered a summer course in field marine biology at the Isle of Shoals just off the Coast of New Hampshire. In 1969 this course is being expanded, in cooperation with the University of New Hampshire, to provide a broader introduction to all aspects of marine sciences.

The following degrees are offered in the basic sciences:

1. A.B. in biology, chemistry, geology, physics
2. B.S. in chemical, civil, electrical or mechanical engineering
3. M.S. in biology, chemistry, geology, physics
4. Ph.D. in biology, chemistry, geology, physics

In addition to basic and supporting courses in chemistry, languages, mathematics, physics, geology, and biology, Cornell undergraduates and graduate students can take regularly scheduled courses covering the areas of general oceanography, marine ecology, invertebrate zoology, marine algae, field marine biology, ichthyology, fishery biology, climatology, sediments, hydrogeology, invertebrate and micropaleontology. Comparative anatomy, animal physiology, and mamalogy are taught by persons with extensive marine experience. Supporting and advanced courses are found in the general areas of limnology, conservation, engineering (Water Resources Center), and maritime law (Law School). Although no regularly scheduled courses exist, Cornell staff includes persons with professional abilities to direct honors programs, individual research, or similar courses in marine bacteriology, marine mycology, marine virology, diseases of marine animals, marine biochemistry, salt marsh ecology, and others.

The following courses are offered in conjunction with the above programs:

| | | |
|------------|------|---------------------------------------|
| B.S. | 469 | Biology of Fishes |
| B.S. | 316 | Invertebrate Zoology |
| B.S. | 344 | Biology of the Algae |
| B.S. | 374 | Field Marine Biology |
| B.S. | 460 | Marine Ecology |
| B.S. | 461 | Oceanography |
| B.S. | 470 | Ichthyology |
| Cons. | 439 | Fish Ecology |
| Cons. | 440 | Fishery Science |
| Cons. | 441 | Fishery Resource Management |
| Geol. Sci. | 441 | Geomorphology |
| Geol. Sci. | 444 | Geological Oceanography |
| Geol. Sci. | 551 | Geochemistry |
| Civil Eng. | 2301 | Fluid Mechanics |
| Civil Eng. | 2315 | Advanced Fluid Mechanics |
| Civil Eng. | 2316 | Advanced Fluid Mechanics |
| Civil Eng. | 2331 | River and Coastal Engineering |
| Civil Eng. | 2512 | Microbiology of Water and Waste Water |

The instructional staff for the courses listed above consists of the following:

Division of Biological Sciences:

Morison, R.S., M.D., Professor, Director, Division of Biological Sciences
Anderson, John M., Ph.D., Professor of Zoology
Barlow, John P., Ph.D., Associate Professor of Oceanography
Gilbert, Perry W., Ph.D., Professor of Zoology
Kingsbury, John M., Ph.D., Associate Professor of Botany

Division of Biological Sciences—Continued

McFarland, William N., Ph.D., Associate Professor of Zoology

Raney, Edward C., Ph.D., Professor of Zoology

Seeley, Harry W., Ph.D., Professor and Chairman Section of Microbiology

Department of Conservation:

Webster, Dwight A., Ph.D., Professor Fishery Biology, Chairman

Carlson, Clarence A., Ph.D., Assistant Professor Fishery Biology

Oglesby, Ray T., Ph.D., Associate Professor of Aquatic Studies

Department of Geological Sciences:

Kiersch, George A., Ph.D., Professor and Chairman

Bloom, Arthur L., Ph.D., Professor of Geological Sciences

Department of Water Resources Engineering:

Gates, Charles D., M.S., Professor and Chairman

Behn, Vaughn C., D. Engineering Associate Professor of Civil Engineering

Dworsky, Leonard B., M.S., Professor Civil Engineering Director, Water Resources Center

Liggett, James A., Associate Professor Civil Engineering

Brutseart, Wilfried, Associate Professor Civil Engineering

To obtain further information, address all inquiries directly to:

Dr. R. S. Morison, Director

Division of Biological Sciences

Cornell University

Ithaca, New York 14850

THE UNIVERSITY OF DELAWARE Newark, Delaware

The University of Delaware Marine Laboratories form a part of the Department of Biological Sciences and have major facilities at two centers: a Marine Biology Laboratory on the University campus at Newark where the office of the Laboratories' director, library, class rooms, and research facilities are located and the Field Station facilities located in Lewes, Delaware, at the mouth of Delaware Bay. The Field Station comprises three laboratories: Bayside Laboratory, which is a research facility; the Shellfish Culture Laboratory, which is equipped for year-round operation in the rearing of shellfish under controlled conditions; and the Cape Henlopen Laboratory, which is being developed for summer course work and research.

The 46-foot R/V Wolverine is equipped as a stern trawler capable of doing trawling, dredging and light coring, and has davits and booms for hydrographic and plankton collections. It is equipped with 110v. AC, Loran, radar, berths and accommodations for five, two crew and three scientists. In addition there are several smaller boats with outboard motors.

The following degrees are offered by the University:

Department of Biological Sciences:

1. Bachelor of Science—at least 30 semester hours which include the 5 core courses: B 201—Concepts in Biology, B 202—Developmental Biology, B 301—Cellular and Molecular Biology, B 302—Environmental Biology, and B 303—Genetic and Evolutionary Biology. These biology courses are supplemented with courses in chemistry, mathematics and physics, and one foreign language.

2. Master of Science—30 hours credit including research, thesis, reading knowledge of one foreign language.

3. Doctor of Philosophy (with specialization in Marine Biology)—course work deemed necessary by Advisory Committee, independent research work with dissertation, and reading knowledge of 2 foreign languages, one of which could be substituted for by computer science.

Department of Geology:

1. Bachelor of Science—at least 30 credit hours which include GEO 105-6—General Geology, 201-2—Mineralogy and Optical Mineralogy, GEO 301—Paleontology, GEO 302—Sedimentation and Stratigraphy, GEO 304—Igneous and Metamorphic Petrology, and GEO 403—Structural Geology. These courses are supplemented by courses in physics, chemistry, and mathematics, and one foreign language.

2. Master of Science—

A. Demonstrated ability to read scientific literature in one foreign language.

B. A qualifying written examination to be taken at least nine months before the date of anticipated graduation.

C. An oral examination administered by the student's thesis committee after completion of the M.S. thesis.

3. Doctor of Philosophy—

A. The general requirements imposed by the University.

B. Oral and written qualifying examinations in which the student demonstrates

i. the breadth and depth of his knowledge of major geologic phenomena and processes;

ii. his knowledge of his field of specialization (e.g., sedimentation—stratigraphy, marine geology, geochemistry) within the broader field of geology;

iii. his knowledge of a minor field related to his area of specialization. The student's committee will include, if possible, an outside examiner.

The following courses are offered in conjunction with the above programs:

Department of Biological Sciences:

| | | | |
|-------|---------------------------|----|---|
| B 627 | Introductory Oceanography | F | 4 |
| B 628 | Marine Biology | Su | 6 |
| B 629 | Physical Oceanography | Su | 3 |

Department of Biological Sciences—Continued

| | | | |
|-------|--|----|-----|
| B 630 | Ichthyology | * | 4 |
| B 631 | Biological Oceanography | F | 4 |
| B 634 | Invertebrate Zoology | * | 4 |
| B 638 | Marine Botany | Su | 3 |
| B 639 | Topics in Marine Ecology | | 3 |
| B 827 | Colloquium in Marine Sciences (Offered each year on different topics; may be repeated with each change of topic) | | 2-4 |
| B 828 | Marine Invertebrates | * | 4 |
| B 838 | Marine Fouling | | 3 |
| B 866 | Special Problem: Tidal Marsh Studies | | 3 |

Geology Department

| | | | |
|---------|---------------------------------|-----|---|
| GEO 301 | Paleontology | F | 4 |
| GEO 302 | Sedimentation and Stratigraphy | Sp | 4 |
| GEO 406 | Introduction to Geophysics | Sp | 3 |
| GEO 601 | Advanced General Geology | F | 2 |
| GEO 602 | Advanced General Geology | Sp | 2 |
| GEO 631 | Marine Geology | | 3 |
| GEO 632 | Recent Sedimentary Environments | Su | 3 |
| GEO 646 | Geochemistry | | 3 |
| GEO 805 | Petrology of Sedimentary Rocks | F* | 3 |
| GEO 806 | Micropaleontology | Sp* | 4 |
| GEO 811 | Stratigraphy | F* | 3 |
| GEO 814 | Introduction to Geophysics | Sp* | 3 |

The University also offers undergraduate and graduate programs in ocean engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Marine Laboratories:

Daiber, Franklin C., Ph.D., Professor of Biology and Director, Marine Laboratories; ichthyology and ecology.

Wells, Harry W., Ph.D., Associate Professor; invertebrate zoology; marine ecology.

Price, Kent S., Ph.D., Assistant Professor and Director of the Field Station; physiology of fish; marine ecology.

Maurer, Donald L., Ph.D., Assistant Professor; marine ecology; biology of marine shellfish.

Myers, Thomas D., Ph.D., Assistant Professor; biological oceanography; marine ecology.

Taylor, Jonathan, Ph.D., Assistant Professor; marine biology; algology.

Geology Department:

Jordan, Robert R., Ph.D., Assistant Professor; stratigraphy; sedimentary petrology; study of suspended matter; Pleistocene shorelines.

Kraft, John C., Ph.D., Associate Professor; recent sedimentary environments; Delaware coast; paleoecology.

Sheridan, Robert E., Ph.D., Assistant Professor; marine geophysics.

Pickett, T. E., Ph.D., Assistant Professor; marine sedimentation.

To obtain further information, address all inquiries directly to:

Dr. Franklin C. Daiber
Director, Marine Laboratories
University of Delaware
Newark, Delaware 19711

Dr. John C. Kraft
Department of Geology
University of Delaware
Newark, Delaware 19711

*Offered in alternate years

DUKE UNIVERSITY
Durham, North Carolina

The Duke University Marine Laboratory (DUML) is an interdepartmental and interuniversity facility for training and research in the marine sciences. It is open throughout the year with an academic and technical staff in residence. It presently occupies fifteen acres of the southern portion of Pivers Island, Beaufort, North Carolina. The U.S. Bureau of Commercial Fisheries Biological and Radiobiological Laboratories encompass the remainder of the island, the northern end. The present plant consists of eighteen buildings, including three dormitories capable of housing forty-six people, a large dining hall, two residences, boat house, store house for ship's gear, classroom laboratories and five air-conditioned research buildings.

The station operates a well-equipped 118-foot research vessel EASTWARD for training and research in oceanography, a 55-foot trawler for off-shore investigations, and a 39-foot cabin powerboat for trawling and dredging in surrounding sounds and estuaries. A 17-foot fiberglass speedboat, row-boats with outboard motors, and collecting gear are also available. The DUML library receives 125 current periodicals and is complemented by added holdings of the Bureau of Commercial Fisheries Laboratories and the University of North Carolina Institute of Marine Science which are located in the Beaufort-Morehead City area.

Separate degrees are not offered in the marine sciences, but a student may pursue work for the A.M. and Ph.D. degrees in Botany and Zoology with concentration of courses in Marine Biology and Oceanography and a thesis in one of these areas. For the A.M. degree in Geology, course work may be taken and a thesis written in Marine Geology or Geological Oceanography.

In Botany the student's graduate program is planned to provide broad basic training in the various fields of botany, plus intensive specialization in the field of the research problem. Graduate courses in the Department of Geology are designed to provide training in the field of environmental sedimentary geology with specialized training in bio-environments, litho-environments, or modern environments.

Required work for the A.M. degree in zoology ordinarily includes 12 units of advance course work in zoology, 6 units of course work in a minor department, and an additional 6 units of advanced work in the major or minor department, or in other pertinent departments. Furthermore, an acceptable thesis is necessary for the fulfillment of the degree requirements.

Normally the program for the Ph.D. degree includes graduate courses in several fields of zoology, courses in the minor subject, wide reading in science in general and in biology in particular, research, and a dissertation based on original work. Minor work is available in many fields, including anatomy, biochemistry, botany, chemistry, geology, physics, physiology and psychology.

A graduate student working for the Ph.D. degree usually takes course work on the main Durham Campus during the academic year and more specialized courses in the summer in the marine sciences at the Duke University Marine Laboratory. By the end of his second year, he is expected to have passed an oral preliminary examination in his department. Thereafter, he is free to do his thesis research without further course requirements on the Durham and/or DUML campuses.

Training in the marine sciences at Duke University and the Duke University Marine Laboratory is at the senior-graduate level in the departments of Botany, Geology and Zoology. Students are free to elect courses in any of the science departments including those in the Schools of Medicine and Engineering.

The following courses are offered in conjunction with the above programs:

Botany—Senior-Graduate

| | | | |
|---------|--------------------------------------|-------|---|
| 207 | Marine Mycology | Su | 6 |
| 211 | Marine Phycology | Su | 6 |
| 220 | Coastal Field Botany (when required) | Su | 6 |
| 225–226 | Special Problems | Su | 6 |
| 255 | Plant Systematics | Sp | 4 |
| 259 | The Environment | F | 4 |
| | Seminar | F, Sp | |

Graduate

359–560 Research in Botany

Geology—Senior-Graduate

| | | | |
|---------|--|--------|---|
| 204 | Physical Oceanography | Su | 6 |
| 205 | Geological Oceanography | Su | 6 |
| 222 | Sedimentary Minerals | F, Sp | 3 |
| 235 | Carbonate Sedimentation and Geochemistry | F | 3 |
| 241–242 | Invertebrate Paleontology | F, Sp* | 6 |
| 243–244 | Micropaleontology | F, Sp* | 6 |
| 247 | Paleoecology | F, Sp* | 3 |
| 305 | Physical Environments Seminar | | |

Zoology—Senior-Graduate

| | | | |
|-----|---|----|--------|
| 203 | Marine Ecology | Su | 6 |
| 214 | Biological Oceanography | F | 6 |
| 216 | Limnology | Sp | 3–4 |
| 238 | Systematic Zoology | F | 4 |
| 240 | Chemical Oceanography (Chemistry 240) | Su | 6 |
| 250 | Physiological Ecology of Marine Animals | Su | 6 |
| 274 | Marine Invertebrate Zoology | Su | 6 |
| 278 | Invertebrate Embryology (when required) | | 4 or 6 |

Graduate

| | | | |
|----------|--------------------------------|-------|--|
| 351, 352 | Departmental Seminar | F, Sp | |
| 353, 354 | Research | | |
| 355, 356 | Seminar | | |
| | Advanced Oceanographic Seminar | | |

The instructional staff for the courses listed above consists of the following:

BOTANY DEPARTMENT

Johnson, Terry W., Ph.D., Chairman and Professor of Botany, Marine Mycology
 Billings, William Dwight, Ph.D., James B. Duke Professor of Botany, Plant Ecology
 Searles, Richard B., Ph.D., Assistant Professor of Botany, Marine Phycology
 Wilbur, Robert L., Ph.D., Associate Professor of Botany, Plant Systematics

GEOLOGY DEPARTMENT

Heron, Stephen Duncan, Ph.D., Chairman and Associate Professor of Geology, Sedimentary Petrology
 Blanton, Jackson O., Ph.D., Assistant Professor of Geology, Physical Oceanography
 Lynts, George W., Ph.D., Assistant Professor of Geology, Micropaleontology
 Perkins, Ronald, Ph.D., Associate Professor of Geology, Sedimentology
 Pilkey, Orrin H., Ph.D., Associate Professor of Geology, Marine Geology

ZOOLOGY DEPARTMENT

Horn, Edward C., Ph.D., Chairman and Professor of Zoology, Cytochemistry
 Bailey, Joseph R., Ph.D., Professor of Zoology, Vertebrate and Systematic Zoology
 Bookhout, Cazlyn G., Ph.D., Professor of Zoology & Acting Director of Oceanographic Program, Invertebrate Embryology and Zoology
 Costlow, John D., Jr., Ph.D., Professor of Zoology and Director of Duke University Marine Laboratory, Invertebrate Embryology and Zoology
 Doyle, Roger, Ph.D., Assistant Professor of Zoology, Ecology and Biological Oceanography
 Fluke, Donald J., Ph.D., Professor of Zoology, Biophysics
 Gray, Irving E., Ph.D., Professor of Zoology (Retired), Ecology
 Hunter, Wanda S., Ph.D., Associate Professor of Zoology (Retired), Marine Parasitology
 Livingstone, Daniel A., Ph.D., Professor of Zoology, Limnology

*Given Biennially

Stefansson, Unsteinn, Ph.D., Adjunct Professor of Zoology, Chemical Oceanography
Vernberg, F. John, Ph.D., Professor of Zoology & Assistant Director of Duke University
Marine Laboratory, Physiological Ecology

Wainwright, Stephen A., Ph.D., Associate Professor of Zoology, Invertebrate Zoology

Wilbur, Karl M., James B. Duke Professor of Zoology, Cellular Physiology

Applications. A student who wishes to apply for graduate work at Duke University should write to the Director of Graduate Studies of the Department of his particular interest, Duke University, Durham, N. C. 27706, or the Dean of the Graduate School for a graduate catalogue and application blanks. Applications for Graduate School should be submitted before February 1.

Students who wish to attend summer courses at Duke University Marine Laboratory should write Dr. John D. Costlow, Jr., Director, Duke University Marine Laboratory, Beaufort, N. C. 28516, for a bulletin and application blank. Applications should be completed before March 10.

FLORIDA ATLANTIC UNIVERSITY Boca Raton, Florida

Florida Atlantic University offers ocean engineering and marine science courses at its main campus in Boca Raton, Florida. Florida Atlantic University is an upper division university (junior and senior years plus graduate work) which includes a College of Science and a separate Department of Ocean Engineering. It is a part of the State of Florida University system. Students entering FAU must have successfully completed two years at a junior college or the equivalent at a four year institution and meet the prerequisites of the department they desire to enter.

The Department of Biological Sciences is housed in a new five-story building which includes modern laboratory facilities for teaching and research in the areas of botany, microbiology, and zoology. Faculty interest and research are strongly oriented toward tropical inshore marine biology with particular emphasis on ecology and environmental contamination. In addition to the campus facility, the Department, in association with the Sanibel-Captiva Conservation Foundation, operates a marine research station on Pine Island Sound, Sanibel Island, on the southwest coast of Florida. Inshore collecting boats, laboratory space, and student housing are available.

Joint graduate training programs and marine science seminars are also conducted through direct affiliation of the Department with the U. S. Bureau of Commercial Fisheries Tropical Atlantic Biological Laboratory in Miami. The Department also houses the newly established Environmental Contamination Data Center which operates in close conjunction with the marine sciences programs of the University and with similar programs at many national institutions.

The University offers the degree of M.S. in Biological Sciences (Department of Biological Sciences). All students are required to obtain practical research experience in biological sciences with an emphasis in the area of botany, microbiology, or zoology, and to demonstrate competence in one of these areas by satisfactorily completing a comprehensive examination and thesis research. Each student is required to satisfactorily complete a minimum of forty-five (45) quarter credit hours of courses, six of which may be in undergraduate-level courses, including up to six quarter credits of thesis research. Each student must also demonstrate a reading knowledge of a modern foreign language, usually French, German, or Russian.

Courses in the marine sciences are offered during the academic year by the departments of Biological Sciences, Geography (Geology), and Ocean Engineering. Both Biological Sciences and Ocean Engineering offer regular summer and special workshop courses on the Boca Raton campus.

The following courses are offered by the Department of Biological Sciences in conjunction with the M.S. Program (the credits shown are quarter hours).

| | | |
|-----|------------------------------------|---|
| 315 | Marine Biology for Ocean Engineers | 3 |
| 431 | Thallophytes | 5 |
| 446 | Invertebrate Zoology I | 4 |
| 447 | Invertebrate Zoology II | 4 |
| 495 | Introduction to Marine Biology | 4 |
| 504 | Special Problems | 4 |
| 517 | Microbial Ecology | 5 |
| 526 | Algology | 5 |
| 535 | Marine Invertebrate Zoology I | 4 |
| 536 | Marine Invertebrate Zoology II | 4 |
| 543 | General Ichthyology | 4 |
| 544 | Biological Ichthyology | 4 |
| 554 | Physiological Animal Ecology | 5 |
| 556 | Aquatic Ecology | 5 |
| 599 | Master's Thesis Research | 6 |

The University also offers an undergraduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Biological Sciences

Boss, Manley L., Ph.D., Chairman and Professor of Botany
Adams, Ralph M., Ph.D., Assistant Professor of Biology
Courtenay, Walter R., Jr., Ph.D., Assistant Professor of Zoology
Dobkin, Sheldon, Ph.D., Assistant Professor of Zoology
Domey, Richard G., Ed.D., Professor of Biostatistics
Grimm, Robert B., Ph.D., Assistant Professor of Botany
Hoffman, Harrison A., Ph.D., Professor of Microbiology
Kalber, Frederick A., Ph.D., Associate Professor of Zoology
Sgueros, Peter L., Ph.D., Professor of Microbiology
Waddell, Glenn H., Ph.D., Assistant Professor of Microbiology

Affiliate Faculty

Tropical Atlantic Biological Laboratory

Beardsley, Grant, Ph.D., Fishery Research Biologist
Berry, Frederick A., M.S., Research Systematist
Dragovich, Alexander, M.S., Fishery Research Biologist
Hebard, James Frank, Ph.D., Oceanographer
Houde, Edward D., Ph.D., Fishery Research Biologist
Ingham, Merton C., Ph.D., Program Chief, Physical Oceanography Program
Jones, Albert C., Ph.D., Assistant Laboratory Director
Miller, George C., M.S., Research Systematist
Miller, Robert V., Ph.D., Zoologist (Fishes)
Richards, William J., Ph.D., Program Chief of the Developmental Biology of Fishes
Sindermann, Carl J., Ph.D., Laboratory Director
Wilson, Peter C., B.S., Fishery Biologist
Wise, John P., M.S., Program Chief of the Tuna Biology Program

To obtain further information, address all inquiries directly to:

Dr. S. E. Wimberly
Vice-President for Academic Affairs
Florida Atlantic University
Boca Raton, Florida 33432

FLORIDA INSTITUTE OF TECHNOLOGY

Melbourne, Florida

The Institute offers a program in Physical Oceanography. Courses and research in the other fields of marine science and cooperative programs with other institutions emphasize the interrelationships between the various marine sciences. Nine buildings were completed recently and a new science building is scheduled for completion in 1969 to house the 10,000 curie cobalt facility, a 5 million volt linear accelerator, and a subcritical nuclear reactor, as well as classrooms, labs, and faculty offices. A laboratory for the program in physical oceanography will be included in the new science building, as well as a soil mechanics lab to study sound transmission in sediments, an instrument development lab, and a wet analysis chemistry lab. Currently in operation is an 18 foot Fleetwing, FLIT, which is used in coastal surveys. FIT has a computer center equipped with a model 2B IBM 1130 Computer which supports the scientific processing needed for its research projects.

The following degrees are offered by the Institute:

1. M.S. in Physical Oceanography (Department of Oceanography)

The degree of Master of Science in Oceanography may be conferred upon students who have successfully completed a minimum of forty-eight (48) quarter hours of required and elective work. Applicants for admission to the program should have a Bachelor's degree in physics, mathematics, physical science, or engineering from an institution acceptable to the Graduate School. All Physical Oceanography graduate students are required to have a mathematical background through differential equations and one year of chemistry.

A graduate record examination is required for all students seeking the Master of Science degree unless waived by the Dean of the Graduate School.

Admission to the Graduate School does not imply that the work taken by the student will be credited toward a degree. No commitment in this matter has been made until the student is admitted to candidacy for a degree.

The part-time Master of Science candidate in oceanography may either take a comprehensive written and oral examination or write a Master's thesis. Full time graduate students are required to write a Master's thesis.

2. B.S. in Physical Oceanography (Department of Oceanography)

In addition to a basic program in physics, undergraduate students will take such courses as introduction to oceanography, marine geology and geophysics, physical oceanography, marine meteorology, ocean waves, and hydroacoustics. Some field work will be included and each student must write an undergraduate thesis.

The following courses in the marine sciences are offered during the year by the Department of Oceanography. In addition to the programs conducted on campus, FIT also conducts an annual course in Underwater Photography.

Florida Institute of Technology holds a 6 weeks pre-college summer institute for high school seniors and graduates who desire additional training in science and mathematics before entering college. The Institute gives the student special courses in Mathematics, Physics, Chemistry, Oceanography, Space Technology, and English. A special guidance and testing seminar assists the students in discovering the fields for which they are best suited.

| | | |
|-----------|------------------------------|---|
| O301 | Introduction to Oceanography | 3 |
| O302 | Chemical Oceanography | 3 |
| O303 | Physical Oceanography | 4 |
| O401 | Marine Geology | 3 |
| O402 | Ocean Waves and Currents | 3 |
| O403 | Marine Geophysics | 3 |
| O410, 411 | Seminar | 1 |
| O451 | Hydroacoustics | 3 |
| O452 | Marine Meteorology | 2 |
| O491 | Senior Project | 3 |

| | | |
|----------------|--|---|
| O500 | Introduction to Physical Oceanography | 3 |
| O501 | Geological Oceanography | 3 |
| O502 | Biological Oceanography | 3 |
| O503 | Chemical Oceanography I | 3 |
| O504 | Chemical Oceanography II | 3 |
| O506 | Sea Laboratory Techniques | 2 |
| O510 | Seminar | 1 |
| O511 | Tides and Tidal Currents | 1 |
| O512 | Dynamic Oceanography I | 3 |
| O513 | Dynamic Oceanography II | 3 |
| O514 | Dynamic Oceanography III | 3 |
| O515 | Engineering Aspects of Oceanography | 3 |
| O516 | Marine Meteorology | 3 |
| O517 | Marine Thermodynamics | 3 |
| O520 | Hydroacoustics I | 3 |
| O521 | Hydroacoustics II | 3 |
| O530 | Geotechnical Properties of Marine Sediments | 3 |
| O531 | Ocean Waves | 3 |
| O532 | Wind Waves | 3 |
| O540 | Statistical Methods in Oceanography | 3 |
| O550, 551, 552 | Special Topics in Physical Oceanography | 1 |
| O560, 561 | Partial Differential Equations for Physical Oceanography | 3 |
| O597, 598, 599 | Thesis | 3 |

The instructional staff for the courses listed above consists of the following:

Department of Oceanography

Morelock, Jack, Ph.D., Chairman and Professor of Oceanography
Dubbledam, Pieter S., Ph.D., Associate Professor of Oceanography and Physics
Hall, Sheldon R., M.S., Lecturer in Oceanography
Herrera, Luis E., Ph.D. Candidate, M.S., Assistant Professor of Oceanography
Lasater, James A., Ph.D., Professor of Oceanography
Phillips, David R., M.S., Adjunct Lecturer in Oceanography
Webster, George C., Ph.D., Adjunct Professor of Oceanography
Woodbridge, David, Ph.D., Director of Research

To obtain further information, address all inquiries directly to:

Dean, Graduate School
Florida Institute of Technology
Melbourne, Florida 32901

FLORIDA STATE UNIVERSITY
Tallahassee, Florida

The Department of Oceanography, a part of the Science Center at the main campus, offers a graduate program leading to the M.S. and Ph.D. degrees in all phases of oceanography. It presently occupies approximately 20,000 square feet of space in temporary buildings. A wide range of equipment, including a CDC 2400 Computer Center, is available within the Department and science center for all phases of oceanographic research and teaching.

A shore facility at Turkey Point on the Gulf of Mexico, 46 miles from the campus, was dedicated in November, 1968. The facility, with a 180' x 200' boat basin, will accommodate vessels of draft less than 12 feet. The facility will provide a 180' dock, large air-conditioned shop, a laboratory of 8,500 square feet with running sea water, and dormitory space. An air-conditioned 65-foot vessel with collecting equipment, a 30-foot cabin cruiser and several small boats are available for inshore work. Within the Department of Geology is the National Science Foundation Antarctic Marine Geological Research Facility for storing and processing Antarctic sediments.

The Department of Oceanography offers an interdisciplinary program leading to the Master of Science and Doctor of Philosophy degrees in the fields of biological, chemical, geological, and physical oceanography.

The following courses are offered in conjunction with the above programs:

| | | |
|----------|--|------|
| 500 | Elementary Physical Oceanography | 3 |
| 501 | Introduction to Physical Oceanography | 3 |
| 502 | Dynamic Oceanography | 3 |
| 503 | Classical Hydrodynamics | 3 |
| 504 | Marine Hydrodynamics | 3 |
| 505 | Ocean Waves | 3 |
| 506 | Ocean Circulation | 3 |
| 507 | Turbulence | 3 |
| 508 | Geophysical Measurements | 3 |
| 509 | Estuary and Coastline Hydrodynamics | 3 |
| 514 | Dynamics of the Upper Ocean | 3 |
| 515 | Experimental Oceanography | 4 |
| 520 | Elementary Biological Oceanography | 3 |
| 522 | Ecology and Taxonomy of Benthic Communities | 3 |
| 523 | Zooplankton Ecology | 3 |
| 524 | Marine Phytoplankton Ecology | 3 |
| 525 | Marine Phytoplankton Physiology | 3 |
| 527 | Fishery Biology | 3 |
| 530 | Marine Ecology | 12 |
| 535 | Estuarine Pollution | 3 |
| 540 | Elementary Chemical Oceanography | 3 |
| 541 | Marine Chemistry | 3 |
| 545 | Chemical Limnology | 3 |
| 557 | Physics of the Air-Sea Boundary Layer | 3 |
| 558 | Laboratory in Air-Sea Interaction | 5 |
| 561 | Oceanic Zoogeography | 3 |
| 562 | Geomicrobiology | 3 |
| 564 | Marine Microbiology | 4 |
| 570 | Elementary Geological Oceanography | 3 |
| 571, 572 | Geochemistry | 3, 3 |
| 574, 575 | Shoreline Geology | 3, 2 |
| 580 | Advanced Sedimentology | 4 |
| 581 | Bathymetry, Structure, and Tectonics of the Ocean Basins | 4 |

| | | |
|----------|---|----------------|
| 582 | Oceanic Processes of Sedimentation | 3 |
| 583 | Ocean Sediments | 3 |
| 584, 585 | Theoretical Hydrodynamics | 3, 3 |
| 586 | Environments of Marine Deposition | 4 |
| 591 | A, B, C, D. Directed Individual Study | 12, 12, 12, 12 |
| 595 | A, B. Seminar | 1, 1 |
| 597 | A, B, C. Directed Research | 3, 3, 3 |
| 598 | A, B, C. Directed Teaching | 3, 3, 3 |
| 599 | Thesis | 5-9 |
| 629 | A, B, C. Advanced Topics in Geophysical Fluid Dynamics | 3, 3, 3 |
| 695 | A, B. Seminar | 1, 1 |
| 699 | Doctoral Dissertation | 18- |

The instructional staff for the courses listed above consists of the following:

Oppenheimer, Carl H., Ph.D., Professor, Chairman, Biological Oceanography

Ashby, Ebert A., Ph.D., Associate Professor, Biological Oceanography

Garstang, Michael, Ph.D., Associate Professor and Assistant Chairman, Physical Oceanography

Glooschenko, Walter A., Ph.D., Assistant Professor, Biological Oceanography

Goodell, H. Grant, Ph.D., Professor, Director of Antarctic Marine Geology Research Facility;
Marine Geology and Geochemistry

Greenberg, Michael J., Ph.D., Research Associate in Oceanography and Associate Professor in
Biological Sciences, Biological Oceanography

Hadlock, Ronald K., Ph.D., Assistant Professor Meteorology and Oceanography, Physical Ocean-
ography

Harriss, Robert C., Ph.D., Assistant Professor, Chemical Oceanography

Hsueh, Ya, Ph.D., Assistant Professor, Physical Oceanography

Jones, James I., Ph.D., Associate Professor, Geological Oceanography

Krishnamurti, Ruby E., Ph.D., Assistant Professor Oceanography, and Senior Research Associ-
ate Geophysical Fluid Dynamics Institute, Physical Oceanography

Kritzler, Henry, Ph.D., Professor, Marine Ecology

La Rock, Paul A., Ph.D., Assistant Professor, Geomicrobiology

Light, Robley J., Ph.D., Assistant Professor Chemistry and Research Associate in Oceanography,
Chemical Oceanography

Menzel, R. Winston, Ph.D., Associate Professor, Marine Biology

Menzies, Robert J., Ph.D., Professor, Biological Oceanography

Staley, Raymond C., Ph.D., Associate Professor, Physical Oceanography

Warnke, Detlef A., Ph.D., Assistant Professor, Geological Oceanography

Warsh, Kenneth L., Ph.D., Assistant Professor, Physical Oceanography

To obtain further information, address all inquiries directly to:

Dr. Carl H. Oppenheimer

Chairman

Department of Oceanography

Florida State University

Tallahassee, Florida 32306

UNIVERSITY OF FLORIDA
Gainesville, Florida

The University of Florida Marine Laboratory on Seahorse Key, an island about two miles from Cedar Key, consists of a laboratory with fresh and sea water and a ten-room building used as a dormitory and caretaker's quarters.

The University offers the degrees of M.S. and Ph.D. in Geology and Zoology. No specific degrees are offered in Marine Sciences.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

Department of Zoology

| | | |
|-----|--------------------------------|---|
| 308 | Invertebrate Zoology | 5 |
| 309 | Comparative Vertebrate Anatomy | 5 |
| 310 | Embryology | 5 |

Department of Geology

| | | |
|-----|----------------|---|
| 517 | Marine Geology | 4 |
|-----|----------------|---|

GRADUATE COURSES

Department of Zoology

| | | |
|-----|------------------------|---|
| 612 | Marine Ecology | 4 |
| 641 | Comparative Physiology | 5 |
| 651 | Ichthyology | 4 |

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Geology

Brooks, Harold K., Ph.D., Associate Professor of Geology

Department of Zoology

Brookbank, John W., Ph.D., Associate Professor of Zoology

De Witt, Robert, Ph.D., Associate Professor of Zoology

Gilbert, Carter R., Ph.D., Assistant Professor of Zoology

Maturo, Frank J. S., Ph.D., Associate Professor of Zoology

Nordlie, Frank G., Ph.D., Associate Professor of Zoology

Pierce, E. Lowe, Ph.D., Professor of Zoology and Supervisor of Marine Laboratory

To obtain further information, address all inquiries directly to:

Department of Geology

Dr. H. K. Brooks

Department of Geology

University of Florida

Gainesville, Florida 32601

Department of Zoology

Dr. E. Lowe Pierce

Department of Zoology

University of Florida

Gainesville, Florida 32601

**UNIVERSITY OF SOUTH FLORIDA
MARINE SCIENCE INSTITUTE
St. Petersburg, Florida**

The Marine Science Institute of the University of South Florida is located at the Bay Campus in St. Petersburg. The Institute is an interdisciplinary unit involving the cooperation of seven associated departments in three divisions of the University.

The Bay Campus occupies a peninsula about one block wide and two blocks long that extends into Bayboro Harbor, a protected bay opening into Tampa Bay. There are 15 buildings of various sizes with more than 200,000 square feet of floor space. Offices and laboratories are located in the main building. There are five new marine science teaching laboratories and six research laboratories, classrooms, living quarters for about 20 visiting investigators, an auditorium, and many other facilities.

Excellent docking and servicing facilities for oceanographic vessels and smaller boats surround the Bay Campus. The Institute operates a 38-foot catamaran, several smaller boats, and has access to the Florida Board of Conservation's 72-foot trawler. At the dockside is a concrete porpoise tank with water filtration system.

No degree is, as yet, offered by the Institute. (A Master's degree is proposed for the 1969-70 academic year.)

The following courses are offered:

| | | |
|---------|---|---|
| BOT 447 | Marine Botany | 4 |
| BOT 543 | Phycology | 5 |
| BOT 583 | Marine Microbiology | 4 |
| BOT 643 | Advanced Phycology | 4 |
| CHM 613 | Chemistry of the Less Familiar Elements | 4 |
| GLY 503 | Sedimentation I | 3 |
| GLY 504 | Sedimentation II | 3 |
| GLY 604 | Recent Fluvial, Transitional, and Continental Shelf Sedimentation | 3 |
| GLY 605 | Advanced Sedimentation | 3 |
| GLY 621 | Marine Micropaleontology | 6 |
| OGY 311 | Introduction to Oceanography | 3 |
| OGY 521 | Chemical Oceanography | 4 |
| OGY 531 | Geological Oceanography | 4 |
| OGY 541 | Physical Oceanography | 4 |
| OGY 551 | Biological Oceanography | 4 |
| ZOO 519 | Ichthyology | 5 |
| ZOO 523 | Physiology of Marine Animals | 5 |
| ZOO 533 | Physiology of Fishes | 4 |
| ZOO 546 | Marine Invertebrate Zoology I | 5 |
| ZOO 547 | Marine Invertebrate Zoology II | 5 |
| ZOO 613 | Advanced Invertebrate Zoology | 3 |
| ZOO 614 | Plankton Ecology | 4 |
| ZOO 615 | Plankton Systematics | 4 |
| ZOO 619 | Advanced Ichthyology | 5 |

The instructional staff for the courses listed above consists of the following:

Humm, Harold J., Ph.D., Director, and Professor of Marine Science
 Betz, John V., Ph.D., Assistant Professor of Botany and Bacteriology
 Briggs, John C., Ph.D., Chairman and Professor of Zoology
 Bloch, S. C., Ph.D., Associate Professor of Physics
 Dawes, Clinton J., Ph.D., Associate Professor of Botany
 DeWitt, Hugh H., Ph.D., Assistant Professor of Marine Science
 Flynn, Robert W., Sc.D., Assistant Professor of Physics

Friedl, Frank E., Ph.D., Associate Professor of Zoology
Griffin, George M., Ph.D., Associate Professor of Geology
Hopkins, Thomas L., Ph.D., Assistant Professor of Marine Science
Lawrence, John M., Ph.D., Assistant Professor of Zoology
Linton, Joe R., Ph.D., Associate Professor of Zoology
Martin, Dean F., Ph.D., Associate Professor of Chemistry
Simon, Joseph L., Ph.D., Assistant Professor of Zoology
Strong, Paschal, Ph.D., Professor of Psychology
Taft, William H., Ph.D., Director and Associate Professor, Sponsored Research; Assistant Dean
of Academic Affairs
Wagner, Diane, Ph.D., Assistant Professor of Biology

To obtain further information, address all inquiries directly to:

Dr. Harold J. Humm
Director
Marine Science Institute
University of South Florida
830 First Street South
St. Petersburg, Florida 33701

UNIVERSITY OF WEST FLORIDA
Pensacola, Florida

This upper division University offers Marine Science oriented courses on its 1000-acre main campus. The University has research facilities on the main campus, and shares the facilities of the Bureau of Commercial Fisheries Field Station on Sabine Island located on Santa Rosa Island. To implement this University's commitment to the estuarine environment, its research vessel is the ARGONAUT, a 23-foot inboard-outdrive vessel, which is trailerable and especially equipped for estuarine study.

The University offers the degree of B.S. in Biology and Marine Sciences through its Department of Biology and Marine Sciences.* All students are required to meet standard university requirements for academic residence and complete a minimum of 60 hours of junior/senior level work. The student must complete By 310, 311, 320, 321, 343, and 443 plus an additional 20 hours of Marine Sciences related courses.

The following courses in Biology and Marine Sciences are offered in all four academic quarters on the main campus by the Faculty of Biology and Marine Sciences:

| | | |
|------------|-----------------------------|----------|
| By 310 | Molecular Biology | 5 |
| By 311 | Genetics | 5 |
| By 320 | Cell Biology | 5 |
| By 321 | Developmental Biology | 5 |
| By 343 | Organismic Biology | 5 |
| By 440 | Marine Invertebrate Zoology | 5 |
| By 443 | Aquatic Ecology | 5 |
| By 445 | Aquaculture | 5 |
| By 446 | Aquatic and Marine Botany | 5 |
| By 360-379 | Seminar | Variable |
| By 399 | Directed Study | Variable |

The instructional staff for the courses listed above consists of the following:

Faculty of Biology and Marine Sciences

Hopkins, Thomas S., Ph.D., Coordinator of Marine Sciences and Associate Professor of Biology and Marine Sciences

Baylis, John R., Ph.D., Assistant Professor of Biology and Marine Sciences

Butler, Philip A., Ph.D., Associate Faculty, Faculty of Biology and Marine Sciences

Cates, Norman B. Ph.D., Assistant Professor of Biology and Marine Sciences

Chaet, Alfred B., Ph.D., Professor, Biology and Marine Sciences

D'Asaro, Charles N., Ph.D., Assistant Professor of Biology and Marine Sciences

Duke, Thomas W., Ph.D., Associate Faculty, Faculty of Biology and Marine Sciences

Gifford, Charles A., Ph.D., Assistant Professor of Biology and Marine Sciences

Reid, Roger D., Ph.D., Professor, Biology and Marine Sciences

Walsh, Gerald E., Ph.D., Associate Faculty, Faculty of Biology and Marine Sciences

To obtain further information, address all inquiries directly to:

Dr. Alfred B. Chaet
Provost, Gamma College
Professor of Biology and Marine Sciences
The University of West Florida
Pensacola, Florida 32504

*An M.S. in Marine Science is proposed for the 1969-70 academic year.

FRESNO STATE COLLEGE
Fresno, California

In its marine science program the college provides "on campus" courses in Oceanography and Marine Geology. These courses provide the prerequisites and background training for additional instruction on the undergraduate or graduate level at the California State Colleges Marine Laboratories at Moss Landing, California. Classes are conducted both on the home campus in Fresno and at the Marine Station, Moss Landing Marine Laboratories (for detailed information on the Laboratories, consult the Consortia section).

The following degrees are offered:

1. Bachelor of Arts with emphasis in Marine Science
2. Master of Arts with emphasis in Marine Science (thesis required). Students may specialize in biology or geology.

The biology, chemistry and geography departments as well as geology and physics, present foundational courses for students, emphasizing marine science in their programs.

The following courses are offered in conjunction with the above programs:

| | | | |
|-----------|-------------------------------|----|---|
| Phy. 140 | Comparative Animal Physiology | | 4 |
| Zool. 114 | Advanced Invertebrates | | 3 |
| Geog. 205 | Seminar in Regional Geography | | 3 |
| Geol. 109 | General Oceanography | Sp | 4 |
| Geol. 120 | Marine Geology | F | 3 |

The instructional staff for the courses listed above consists of the following:

Biology Department

Tribbey, Bert A., Ph.D., Assistant Professor, Ecology, Invertebrates

Woodwick, Keith H., Ph.D., Professor, Systematics, Invertebrates

Geography Department

Norsworthy, Stanley, C.Phil., Assistant Professor, Coastal Vegetation

Geology Department

White, Stanton, Ph.D., Assistant Professor, Oceanography, Marine Geology

To obtain further information, address all inquiries directly to:

Dr. Stan M. White (for Fresno State College)
Department of Geology
Fresno State College
Fresno, California 93726

or

Dr. Keith Woodwick (for Fresno State College)
Department of Biology
Fresno State College
Fresno, California 93726

or

Moss Landing Laboratories
P. O. Box 223
Moss Landing, California 95039

THE GEORGE WASHINGTON UNIVERSITY
Washington, D. C.

The University offers marine science courses at its main campus in downtown Washington, D. C. and at a number of government installations in the greater Washington area.

The University offers the degree of B.S. in Oceanography through its Columbian College.

All students are required to satisfy many of the undergraduate requirements for the Bachelor of Science degree. In addition specialization in oceanography is obtained by taking 21 hours in oceanography and additional work in geology and geophysics.

The following courses in the marine sciences are offered by the Departments of Mathematics and Geology. The program is administered by the Department of Mathematics under the guidance of a Program Adviser.

| | | |
|------------|----------------------------|-----|
| OCEA 12 | Navigation | 3 |
| OCEA 101-2 | Elementary Oceanography | 3-3 |
| OCEA 110 | Ocean Dynamics | 3 |
| OCEA 111 | Ocean Waves and Tides | 3 |
| OCEA 112 | Biological Oceanography | 3 |
| OCEA 113 | Marine Geophysics | 3 |
| OCEA 114 | Chemical Oceanography | 3 |
| OCEA 115 | Geological Oceanography | 3 |
| GEOL 125 | Marine Geology | 3 |
| GEOL 181-2 | Oceanography I and II | 3-3 |
| GEOP 105 | Elementary Geophysics | 3 |
| GEOP 107 | Land Forms (Geomorphology) | 3 |
| GEOP 115 | Elementary Seismology | 3 |
| GEOP 205 | Advanced Geophysics | 3 |
| GEOP 215 | Advanced Seismology | 3 |

The instructional staff for the courses listed above consists of the following:

Orlin, Hyman, Ph.D., Program Adviser and Professorial Lecturer
 Algermissen, Sylvester T., Ph.D., Associate Professorial Lecturer
 Andersen, Neil R., Ph.D., Assistant Professorial Lecturer
 Buzas, Martin A., Ph.D., Associate Professorial Lecturer
 Espinosa, Alvaro F., M.S., Assistant Professorial Lecturer
 Hicks, Steacy D., M.S., Associate Professorial Lecturer
 Maloney, William E., M.S., Associate Professorial Lecturer
 Morrison, Robert E., Ph.D., Assistant Professorial Lecturer
 Pierce, Jack W., Ph.D., Adjunct Professor of Geology
 Rinehart, Wilbur A., M.S., Lecturer

Rucker, James B., Ph.D., Assistant Professorial Lecturer

To obtain further information, address all inquiries directly to:

Director of Credit Programs
 College of General Studies
 The George Washington University
 706 20th Street, N. W.
 Washington, D. C. 20006

UNIVERSITY OF GEORGIA Athens, Georgia

Modern graduate training and research facilities in marine sciences are available on the Athens campus and at the University's Marine Institute on Sapelo Island, Georgia. In addition, staff and graduate students participate in studies utilizing federally supported ships and other facilities not owned by the University.

Facilities for training and research in the marine sciences at Athens include classrooms and laboratories in all participating departments. At Sapelo Island, modern, well-equipped laboratories occupy more than 10,000 square feet of space. Living accommodations on the Island include family housing units for staff and dormitory space for eighteen. The principal research vessel of the Institute is 65 feet in length and is equipped to carry out investigations on the continental shelf and slope as well as in the estuaries. A fleet of smaller boats is maintained for work in the extensive estuaries and salt marshes of the area. Research at the Institute has centered mainly in the ecology of marshes and estuaries, aquaculture, estuarine pollution, the geochemistry of estuaries and shelf waters, and the geology of the barrier islands and pleistocene shelf deposits.

The University offers the M.S. and Ph.D. degrees with emphasis on marine science in four basic science departments; Botany, Geology, Microbiology and Zoology. No degrees specifically designated as marine science or oceanography are offered. Specific degree requirements vary slightly among the departments, but, in general, 40 credit hours of formal course work, a thesis and a reading knowledge of one foreign language, as well as satisfactory performance on a comprehensive examination in the basic science field involved, are required for the M.S. degree. Formal course requirements for the Ph.D. are flexible, the program being determined by the student in consultation with his advisory committee. Preliminary written and oral examinations and a final oral examination are administered by the department. A reading knowledge of a second foreign language and a dissertation are also required for the Ph.D.

Courses pertinent to graduate training in the biological and physical aspects of marine sciences are offered in the Division of Physical Sciences and Division of Biological Sciences in the College of Arts and Sciences and in the School of Forest Resources. In the college of Arts and Sciences the departments which grant graduate degrees with marine science specialization are: Botany, Microbiology, Zoology and Geology.

Advanced courses that are wholly or partly marine in aspect are listed by department. Courses number 800 or above are strictly graduate, others are senior-graduate. All are based on the Athens campus but may involve trips to the field and to other facilities. Credits are in quarter hours.

Department of Botany

| | | |
|-----|---------------------------------|---|
| 610 | Growth and Development of Algae | 5 |
| 860 | Aquatic Plants | 5 |

School of Forest Resources

| | | |
|-----|------------------|---|
| 767 | Marine Fisheries | 5 |
|-----|------------------|---|

Department of Geography

| | | |
|-----|--|---|
| 601 | Advanced Climatology | 5 |
| 602 | North American Physiography | 5 |
| 620 | Use and Interpretation of Aerial Photographs | 5 |
| 622 | Advanced Photogrammetry Laboratory | 5 |

Department of Geology

| | | |
|-----|--------------------------------|---|
| 603 | Invertebrate Paleontology | 5 |
| 605 | Sedimentation and Stratigraphy | 5 |
| 608 | Optical Mineralogy | 5 |
| 609 | Marine Geology | 5 |
| 610 | Sedimentary Petrology | 3 |
| 611 | Principles of Geochemistry | 3 |
| 612 | Palynology | 5 |
| 613 | Paleobotany | 5 |

Department of Geology--Continued

| | | |
|-----|--|---|
| 630 | Clay Mineralogy | 5 |
| 639 | Introduction to Geophysics | 5 |
| 805 | Advanced Stratigraphy | 3 |
| 811 | Petrography and Petrology of Sedimentary Rocks | 3 |
| 815 | Special Problems in Sedimentology and Oceanography | 5 |
| 820 | Geotectonics | 3 |

Department of Microbiology

| | | |
|-----|------------------------------|---|
| 662 | Aspects of Microbial Ecology | 5 |
| 860 | Physiology of Bacteria | 5 |

Department of Zoology

| | | |
|-----|-------------------------------|---|
| 600 | Bioenergetics and Ecosystems | 5 |
| 605 | Ichthyology | 5 |
| 660 | Marine Ecology | 5 |
| 807 | Advanced Invertebrate Zoology | 5 |
| 808 | Advanced Invertebrate Zoology | 5 |
| 810 | Limnology and Oceanography | 5 |
| 811 | Marine Biology | 5 |
| 812 | Freshwater Biology | 5 |
| 813 | Hydrobiology Seminar | 1 |
| 854 | Physiological Ecology | 5 |
| 855 | Population Ecology | 5 |
| 856 | Ecology Seminar | 1 |
| 857 | Pollution Ecology | 5 |
| 858 | Systems Ecology I | 3 |
| 859 | Systems Ecology II | 3 |

The instructional staff for the courses listed above consists of the following:

University of Georgia Marine Institute

Henry, Vernon J., Ph.D., Director and Associate Professor of Geology
Dahlberg, Michael D., Ph.D., Assistant Professor of Zoology
Greene, Albert G., Ph.D., Assistant Director
Howard, James D., Ph.D., Assistant Professor of Geology
Hoyt, John H., Ph.D., Associate Professor of Geology
Marland, Frederick C., Ph.D., Research Associate in Zoology
Reimold, Robert J., Ph.D., Research Associate in Zoology

Department of Botany

Fuller, Melvin S., Ph.D., Head and Professor of Botany
Duncan, Wilbur H., Ph.D., Professor of Botany
Kochert, Gary, Ph.D., Assistant Professor of Botany

School of Forest Resources

Huish, Melvin T., Ph.D., Assistant Professor of Fisheries
Fox, Alfred C., Ph.D., Unit Leader, Coop. Fishery Unit, USFWS and Assistant Professor of Fisheries

Department of Geology

Hurst, Vernon J., Ph.D., Head and Professor of Geology
Allard, Gilles O., Ph.D., Associate Professor of Geology
Brown, Anton, Ph.D., Assistant Professor of Geology
Carver, Robert E., Ph.D., Assistant Professor of Geology
Noakes, John E., Ph.D., Associate Professor of Geology
Rich, Mark, Ph.D., Associate Professor of Geology
Stanley, Edward A., Ph.D., Associate Professor of Geology
Voorhies, Michael R., Ph.D., Assistant Professor of Geology
Wiedemann, Hartmut, Ph.D., Assistant Professor of Geology

Department of Microbiology

Payne, William J., Ph.D., Head and Professor of Microbiology

Eagon, Robert G., Ph.D., Professor of Microbiology

Wiebe, William J., Ph.D., Assistant Professor of Microbiology

Department of Zoology

Frankenberg, Dirk, Ph.D., Associate Professor of Zoology

Johannes, Robert E., Ph.D., Associate Professor of Zoology

Odum, Eugene P., Ph.D., Alumni Foundation Distinguished Professor of Zoology

Patten, Bernard C., Ph.D., Professor of Zoology

Pomeroy, Lawrence R., Ph.D., Professor of Zoology

Scott, Donald C., Ph.D., Chairman, Division of Biological Sciences and Professor of Zoology

Thomas, Grace J., Ph.D., Associate Professor of Zoology

To obtain further information, address all inquiries directly to:

Dr. E. L. Cheatum, Director

Institute of Natural Resources & Coastal Development

Graduate Studies Research Center

University of Georgia

Athens, Georgia 30601

UNIVERSITY OF GUAM
Agana, Guam

The University's marine sciences facilities are located on the main campus. The 25,000 square-foot science building holds the laboratories and office of the Division of Biosciences and Marine Studies. A marine biological research laboratory is to begin construction in early summer, 1969. The University has a small eighteen foot fiberglass research vessel, M.V. ALU. Sea-water analytical equipment is available. "Micronesica", Journal of the University of Guam, presently in its fourth volume, publishes articles pertaining to the sciences of the Pacific, particularly the Micronesian area.

The University offers the degree of Master of Science in Biology through its Division of Biosciences and Marine Studies. Although the University's biology program is not specifically designed as a marine science-oriented program, the majority of students at the University work with some aspect of marine studies. A total of thirty semester hours is required. Each student must take a Biological Literature and Manuscripts seminar, and at least one biological seminar is required each year while in residence. The remainder of twenty-four semester hours is in course work. A thesis is required of all students. Special problems or directed research is also allowed.

The following courses are offered in conjunction with the above program:

| | | |
|--------|---------------------|---|
| BI 333 | Oceanology | 3 |
| BI 545 | Marine Biogeography | 2 |
| BI 580 | Marine Ecology | 4 |
| BO 420 | Marine Botany | 4 |
| ZO 441 | Ichthyology | 4 |
| ZO 532 | Marine Invertebrate | 4 |

The instructional staff for the courses listed above consists of the following:

Division of Biosciences and Marine Studies

Eldredge, L. G., Ph.D., Chairman and Professor of Biology

Adair, Charles N., Ph.D., Associate Professor of Biology

Chesher, Richard A., Ph.D., Associate Professor of Biology

Davis, Donald M., Ph.D., Associate Professor of Biology

Jones, Robert S., Ph.D., Associate Professor of Biology

Tsuda, R. T., M.S., Assistant Professor of Biology

To obtain further information, address all inquiries directly to:

Dr. Lucius G. Eldredge

Chairman, Division of Biosciences and Marine Studies

University of Guam

Agana, Guam 96910

UNIVERSITY OF HAWAII Honolulu, Hawaii

The laboratory and classroom facilities of the Department of Oceanography are located in the Hawaii Institute of Geophysics on the Manoa campus of the University of Hawaii. In the same building and available for use by the Department are the Geophysics Library and the Statistical and Computing Center containing IBM 1401 and 360 computers.

The Department is closely associated with the Hawaii Institute of Geophysics, a geophysical research institute that, in cooperation with various departments, provides research facilities and appointments in astrophysics, geochemistry, geology, meteorology, oceanography, and geophysics. The Institute also maintains a high-altitude observatory on the summit of Mount Haleakala, Maui, and a seismic vault in upper Manoa Valley.

Other facilities that are available to the Oceanography Department are the Hawaii Marine Laboratory, an ocean-side laboratory on the east coast of Oahu devoted to advanced training, research, and instruction in marine biology; Gregg M. Sinclair Library; the new graduate library and the Honolulu Biological Laboratory of the U. S. Fish and Wildlife Service, a major oceanographic biological research institute located on the University campus.

The marine facilities of the Department are located at Pier 18, Honolulu, a ten minute drive from the University. These include storage buildings, repair shops and docking facilities for the University's research vessel, TERITU, and the various smaller boats used for nearshore research. The TERITU is a 90-foot steel-hulled research vessel converted and over-hauled in 1964 and equipped with the latest oceanographic equipment. She has approximately 480 square feet of electronic and wet laboratory space and well-furnished quarters for six scientists. Smaller boats include a 46-foot decked boat, the SALPA. Two larger research vessels belonging to the U. S. Fish and Wildlife Service are available for use in cooperation with that agency's research program: the GILBERT, 122 feet, and the newly constructed CROMWELL, 158 feet.

The following degrees are offered by the University by the Departments indicated.

1. **Ph.D. in Oceanography (Department of Oceanography).** All students are required to obtain practical research experience in oceanography, to pass a departmental examination and to satisfactorily demonstrate ability to carry out independent research. Although there are no absolute course requirements, the departmental examination will deal with subjects normally covered in Oceanography 620, 621, 622, and 623. Following the satisfactory completion of the examination, the student will normally begin a thesis project. Within a year he takes his University comprehensive, and then completes his thesis. Each student must also display a reading knowledge of one foreign language (German, French, Russian, Spanish, or Japanese). Computer competence is also required.

2. **M.S. in Oceanography (Department of Oceanography).** All students are required to obtain practical field experience in oceanography and to demonstrate competence in oceanography by satisfactorily completing a departmental examination and a thesis project. Each student is required to satisfactorily complete 24 credit hours of graduate level courses which must include Oceanography 620, 621, 622, 623 and a seminar. Computer competence is also required.

3. **M.S. in Botany, Ph.D. in Botany (Department of Botany).** Work required to remedy deficiencies and for degree programs will be decided through a diagnostic examination at the time of enrollment in the department and by continuing faculty counseling. Thesis work may be undertaken in four broad areas: environmental botany; physiology and biochemistry; structure and development; and systematics and evolution. Appropriate organisms for research may be selected from the algae, fungi, ferns, or flowering plants, representing tropical, marine or economic plants.

4. **M.S. in Geosciences, Ph.D. in Geosciences (Department of Geosciences).** Degree candidates must satisfactorily complete a minimum of 18 credit hours of course work and 12 credit hours of thesis research, as well as demonstrate a reading knowledge of one foreign language with useful scientific literature in the field of the candidate.

Geology. Entering students not having year-length courses in elementary geology, physics, chemistry, college mathematics, and geological field methods, and at least one semester of mineralogy, petrology, and structural geology or their equivalent will be obliged to take those courses. Both

the M.S. and Ph.D. examinations may include questions from all of the basic fields of geology, such as mineralogy, petrology, structural geology, stratigraphy, geomorphology, and paleontology.

Solid Earth Geophysics. It is desirable that intended candidates possess undergraduate training equivalent to 20 credit hours in each of mathematics, physics, and geology. Besides geosciences courses, courses may be allowed in engineering, physics, mathematics, and chemistry. Experience with an exploration or research organization will prove beneficial for Ph.D. candidates.

5. M.S. in Microbiology (Department of Microbiology). The department offers programs leading to the M.S. in microbiology with areas of specialization in microbial biochemistry, genetics, and ultrastructure; the biology of infectious diseases; the biochemistry and genetics of viruses; immunology and immunochemistry; marine microbiology and developmental and cell biology. Studies in microbiology emphasize fundamental biological, biochemical, and physical-chemical approaches and not those primarily of an applied or diagnostic nature.

Intended candidates should have adequate undergraduate preparation in both biological and physical sciences, including microbiology, a basic course in either biology, botany or zoology and courses in organic chemistry, biochemistry, calculus, physics. Official scores of the Graduate Record Examination and three letters of recommendation are required of all applicants. Courses for the graduate program are to be selected from those offered in the related fields of biochemistry, biophysics, botany, chemistry, genetics, mathematics, oceanography, public health, and zoology.

6. Ph.D. in Microbiology (Department of Microbiology). The department offers programs leading to the Ph.D. in microbiology with areas of specialization in microbial biochemistry, genetics, and ultrastructure; the biology of infectious diseases; the biochemistry and genetics of viruses; immunology and immunochemistry; marine microbiology and developmental and cell biology. Studies in microbiology emphasize fundamental biological, biochemical, and physical-chemical approaches and not those primarily of an applied or diagnostic nature.

Intended candidates should have adequate undergraduate preparation in both biological and physical sciences, including microbiology, a basic course in either biology, botany, or zoology, and courses in organic chemistry, biochemistry, calculus, and physics. Intended Ph.D. candidates are urged to complete a course in physical chemistry. Deficiencies in undergraduate preparation can be made up in graduate study. Official scores of the Graduate Record Examination and three letters of recommendation are required of all applicants.

Courses for the graduate program are to be selected from the microbiology course offerings and from others offered in the related fields of biochemistry, biophysics, botany, chemistry, genetics, mathematics, oceanography, public health, and zoology. Microbiology 690 and 699 are required.

7. M.S. in Zoology (Department of Zoology). Intended candidates for the M.S. in zoology must present a minimum of 18 hours of undergraduate preparation in zoology, including courses in vertebrate zoology (including comparative anatomy), embryology, and physiology. They should have completed two years of chemistry (inorganic and organic), and courses in calculus, botany, and one year of physics. Deficiencies in undergraduate preparation must be made up. An official record of the student's performance on the Graduate Record Examination (Aptitude Test and the Advanced Test in Biology) must be submitted to the chairman of the zoology department. One seminar each year is required. For the M.S. program under Plan A a maximum of 6 hours, and under Plan B a minimum of 6 hours, may be elected from related courses in botany, chemistry, entomology, genetics, mathematics, meteorology, oceanography, and physics.

8. Ph.D. in Zoology (Department of Zoology). Intended candidates for the Ph.D. in zoology must present a minimum of 18 hours of undergraduate preparation in zoology, including courses in vertebrate zoology (including comparative anatomy), embryology, and physiology. The student should have completed two years of chemistry (inorganic and organic), and courses in calculus, botany, and one year of physics. Deficiencies in undergraduate preparation must be made up. An official record of the student's performance on the Graduate Record Examination (Aptitude Test and the Advanced Test in Biology) must be submitted to the chairman of the zoology department. One seminar each year is required. Zoology 702 and 800 are required for Ph.D. candidates. Additional work will be stipulated by the supervising committee. Candidates must pass a reading examination in one foreign language.

The following courses are offered in conjunction with the above programs:

Oceanography

| | | |
|-----|--|---|
| 201 | Science of the Sea | 3 |
| 620 | Physical Oceanography | 3 |
| 621 | Biological Oceanography | 3 |
| 622 | Geological Oceanography | 3 |
| 623 | Chemical Oceanography | 2 |
| 632 | Littoral Geological Processes | 3 |
| 633 | Chemical Oceanography Laboratory Methods | 2 |
| 636 | Phytoplankton Ecology | 2 |
| 640 | Advanced Physical Oceanography | 3 |
| 642 | Recent Marine Sediments | 3 |
| 643 | Marine Geochemistry | 3 |
| 644 | Marine Geological and Geophysical Techniques | 3 |
| 646 | Zooplankton Ecology | 2 |
| 647 | Zooplankton Ecology Laboratory | 2 |
| 660 | Ocean Wave Theory | 3 |
| 661 | Tides | 3 |
| 662 | Marine Hydrodynamics | 3 |
| 663 | Measurements and Instrumentation | 2 |
| 672 | Ocean Basins | 3 |
| 673 | Continental Shelves | 3 |
| 701 | Nekton Ecology | 2 |
| 735 | Seminar in Oceanography | 2 |
| 750 | Topics in Biological Oceanography | 2 |
| 760 | Topics in Physical Oceanography | 2 |
| 770 | Seminar in Chemical Oceanography | 1 |

Botany

| | | |
|---------|---------------------------------|---|
| 480 | Phycology | 3 |
| 651 | Dynamics of Marine Productivity | 3 |
| 631 | Marine Phytoplankton | 3 |
| 681-684 | Advanced Phycology | 2 |

Geosciences

| | | |
|-----|-------------------|---|
| 320 | Marine Geology | 3 |
| 661 | Marine Geophysics | 3 |

Microbiology

| | | |
|-----|-------------------|---|
| 480 | Microbial Ecology | 4 |
|-----|-------------------|---|

Zoology

| | | |
|-----|--------------------------------------|---|
| 620 | Marine Ecology | 3 |
| 629 | Methods of Fisheries Investigation | 3 |
| 716 | Topics in Fish and Fisheries Biology | 3 |

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Oceanography

Murphy, Garth I., Ph.D., Chairman and Professor of Oceanography
 Andrews, James E., Ph.D., Assistant Professor of Oceanography
 Brock, Vernon E., M.A., Professor of Oceanography
 Caperon, John, Ph.D., Associate Professor of Oceanography
 Cattell, Allen S., Ph.D., Assistant Professor of Oceanography
 Chave, Keith E., Ph.D., Professor of Oceanography
 Clarke, Thomas A., Ph.D., Assistant Professor of Oceanography
 Clutter, Robert I., Ph.D., Associate Professor of Oceanography

Department of Oceanography--Continued

Gallagher, Brent, Ph.D., Assistant Professor of Oceanography
Gordon, Donald C., Ph.D., Assistant Professor of Oceanography
Graefe, Volker, Ph.D., Assistant Geophysicist
Groves, Gordon W., Ph.D., Professor of Oceanography
Malahoff, Alexander, Ph.D., Assistant Geophysicist
Roy, Kenneth, Ph.D., Assistant Professor of Oceanography
Stroup, Edward D., M.A., Associate Oceanographer
Wyrski, Klaus, Ph.D., Professor of Oceanography

Department of Botany

Doty, Maxwell, Ph.D., Professor of Botany

Department of Geosciences

Sutton, George H., Ph.D., Professor of Geosciences
Moberly, Ralph, Jr., Ph.D., Associate Professor of Geosciences
Ramage, Colin S., Sc.D., Professor and Chairman of Geosciences

Department of Microbiology

Gundersen, Kaare, R., Ph.D., Associate Professor of Microbiology

Department of Zoology

Ebert, Thomas A., Ph.D., Assistant Professor of Zoology
Banner, Albert H., Ph.D., Professor of Zoology
Reese, Ernst S., Associate Professor, Zoology

To obtain further information, address all inquiries directly to:

Dean Wytze Gorter
Graduate Division
University of Hawaii
Honolulu, Hawaii 96822

Dr. Garth L. Murphy, Chairman
Department of Oceanography
University of Hawaii
Honolulu, Hawaii 96822

HUMBOLDT STATE COLLEGE
Arcata, California

The marine science programs at Humboldt State College offer instruction and opportunities for research in marine fisheries, oceanography, and the marine aspects of zoology, botany and ecology. Present facilities include saltwater aquaria, a water chemistry laboratory, ichthyology laboratories, and zoology and botany classrooms and laboratories. A 40-foot research vessel equipped with standard oceanographic and biological instrumentation is available. A marine sciences laboratory with a modern saltwater system is located at Trinidad, California.

The College offers the following degrees through the Divisions indicated:

Division of Natural Resources

1. Bachelor of Science in Oceanography

- a. General education: Required and elective courses to insure cultural breadth in the humanities, social sciences, and English and speech.
- b. Lower division requirements: Math 5 ABC, Physics 4 ABCD, Geol. 1, Chem. 20 ABC, Biol. 3, Zool. 1, Bot. 1, Biol. 40 or Math 25.
- c. Upper division requirements: Chem 101, Chem 102, Ocn 100, Ocn 101, Ocn 102, Ocn 103 AB, Ocn 106, Ocn 180, Ocn 190, Ocn 199.
- d. 25 Units of approved science courses.
- e. Free electives to bring total units for the B.S. Degree to 192 quarter units.

Division of Biological Sciences

2. Bachelor of Arts in Biology

- a. General education: Required and elective courses to insure cultural breadth in the humanities, social sciences, and English and speech.
- b. Lower division requirements: Biology 3, Botany 1, Zoology 1, Chemistry 10A-10B, Physics 15A-15B.
- c. Upper division requirements: Biology 114, 119; Chemistry 128.
- d. Completion of one of the following options:
 - Biology option: Biology 107; Botany 110, 120; Zoology 101 or Botany 101; Zoology 112, Zoology 114 or 116; Mathematics 8 units beyond Math C and including Nat Res 40 as an alternative.

Medical Technology option: Biology 103, 120, 124; Botany 130; Zoology 101, 120, 121, 166, 174; Chemistry 11, 101, 102.

- e. Free electives to bring total units for the A.B. degree to 186. Sixty of the total units must be upper division, 36 of which must be in approved upper division science courses.

3. Master of Arts in Biology

The following requirements are prescribed for the degree of Master of Arts in Biology:

- a. Completion of 45 upper division or graduate units in biology or supporting courses approved by the graduate committee including a minimum of 18 units of graduate courses.
- b. Oral preliminary examination by graduate committee to be taken prior to registration of the last 30 units. The purpose of this examination is to establish the candidate's deficiencies and required courses. No one fails this examination; however, the candidate may be asked to repeat the examination and a poor showing may necessitate repetition of lower division and undergraduate courses without credit.
- c. Completion of a total of not less than 8 units or more than 10 units of 290 and 299 and a thesis approved by the graduate committee:

-OR-

A special problem to be completed concurrently in enrollment of a total of 4 units of 290 and 299. Students electing to do a special problem rather than a thesis may not apply more than 4 units of 125, 19, 290 or 299 toward the 45 required units.

- d. A final oral examination by the graduate committee. This will include a defense of the thesis for students electing to write a thesis.

4. Bachelor of Arts in Botany

a. General education: Required and elective courses to insure cultural breadth in the humanities, social sciences, and English and speech.

b. Lower division requirements: Biol. 3, Bot. 1, Chem. 10A-10B, Physics 15A-15B, Zool. 1, Math 15A-15B.

c. Upper division requirements: Biol. 114; Bot. 101, 110, 121, 122, 126, 130, 140 or 145, 150-151 (or Biol. 107), Biol. 125 or 129; Chem. 128, one course in zoology or physiology (3-5 units).

d. Free electives to bring total units for the A.B. degree to 186. Sixty of the total units must be upper division.

5. Bachelor of Arts in Zoology

a. General education: Required and elective courses to insure cultural breadth in the humanities, social sciences, and English and speech.

b. Lower division requirements: Biol. 3, Bot. 1, Chem. 10A-10B, Physics 15A-15B, Zool. 1, Math. 15A-15B.

c. Upper division requirements: Biol. 107, 114; Zool. 101, 112, 114 or 116, 143, 160; Chem. 128; one Botany course (3-5 units).

d. Free electives to bring total units for A.B. degree to 186. Sixty of the total units must be upper division.

The following courses are offered on conjunction with the above programs (credits are in quarter hours):

Courses in Oceanography:

Upper Division Undergraduate Courses

| | | |
|------------|---|-----|
| 100 | General Oceanography | 5 |
| 101 | Biological Oceanography | 4 |
| 102 | Physical Oceanography | 4 |
| 103A, 103B | Chemical Oceanography | 3-3 |
| 105 | Methods and Instruments of Oceanography | 2 |
| 106 | Geological Oceanography | 3 |
| 112 | Advanced Physical Oceanography | 3 |
| 116 | Marine Sedimentation | 4 |
| 121 | Zooplankton Ecology | 4 |
| 125 | Field Problems | 1-3 |
| 126 | Beach and Nearshore Processes | 3 |
| 131 | Marine Radioecology | 3 |
| 180 | Undergraduate Seminar | 1 |
| 181 | Seminar in Biological Oceanography | 1 |
| 182 | Seminar in Physical Oceanography | 1 |
| 183 | Seminar in Chemical Oceanography | 1 |
| 186 | Seminar in Geological Oceanography | 1 |
| 190 | Field Cruise | 1 |
| 199 | Independent Study | 1-3 |

Division of Biological Sciences:

Courses in Biology:

Upper Division Undergraduate Courses

| | | |
|-----|----------------|---|
| 141 | Marine Biology | 4 |
|-----|----------------|---|

Courses in Botany:

Upper Division Undergraduate Courses

| | | |
|-----|------------------|---|
| 145 | Marine Phycology | 4 |
|-----|------------------|---|

Graduate Courses

| | | |
|-----|-----------------------------------|---|
| 231 | Marine Mycology | 4 |
| 245 | Physiological Ecology of Seaweeds | 4 |

Courses in Zoology:

Upper Division Undergraduate Courses

| | | |
|-----|---------------------------|---|
| 112 | Invertebrate Zoology | 5 |
| 142 | Ecology of Marine Animals | 4 |
| 143 | Invertebrate Physiology | 4 |

Graduate Courses

| | | |
|-----|-------------------------------|---|
| 212 | Advanced Invertebrate Zoology | 4 |
| 242 | Benthic Ecology | 3 |
| 244 | Invertebrate Embryology | 4 |

The University also offers an undergraduate program in fisheries which is described in the Fisheries section of this publication.

The instructional staff for the courses listed above consists of the following:

Division of Biological Sciences

Allen, William V., Ph.D., Assistant Professor of Zoology
Beilfuss, Erwin, Ph.D., Professor of Zoology
Brusca, Gary, Ph.D., Assistant Professor of Biology
DeMartini, John D., Ph.D., Associate Professor of Biology
Houck, Warren J., Ph.D., Professor of Zoology
Rasmussen, Robert A., Ph.D., Assistant Professor of Botany
Waters, James, Ph.D., Assistant Professor of Zoology

Division of Natural Resources

Crandell, George F., Ph.D., Assistant Professor of Oceanography
Gast, James A., Ph.D., Associate Professor and Coordinator of Oceanography, Director of Marine Laboratory
Reinert, Richard L., B.S., Assistant Professor of Oceanography
Thompson, Robert W., Ph.D., Assistant Professor of Oceanography

To obtain further information, address all inquiries directly to:

Dr. James A. Gast
Director, Marine Laboratory
Humboldt State College
Arcata, California 95521

THE JOHNS HOPKINS UNIVERSITY

Baltimore, Maryland

Macaulay Hall, on the Homewood Campus of the University, offers adequate office, laboratory and shop space for all branches of the oceanographic program. Other experimental facilities are available in Maryland and Latrobe Halls. The laboratories are well equipped with the general and specialized equipment required for oceanographic research. Photographic, drafting and data reduction facilities are available to students; an extensive and active Computing Center is maintained on campus.

In addition, the resources of the Chesapeake Bay Institute, a division of the University engaged in oceanographic contract research, are available to students in the Department of Earth and Planetary Sciences. The C.B.I. research vessels are docked at the Institute's field laboratory at Annapolis, about an hour's drive from the campus. The 106-foot catamaran R/V RIDGELY WARFIELD is the largest of the Institute's vessels, specifically designed for research in estuarine and coastal waters. The 70-foot R/V MAURY and several smaller vessels are included in the fleet. A large barge is available for long term, on-station studies. Included in the Institute is an engineering design group for the development of new oceanographic instruments.

The Department of Earth and Planetary Sciences has an agreement with the Smithsonian Institution in Washington, D. C., which permits students to use their facilities should this be required for their research.

The Department will accept candidates for either a M.A. or Ph.D. program. Candidates for the M.A. in Oceanography must complete a prescribed program of course work in Oceanography, demonstrate a reading knowledge of French, German or Russian, complete an essay based on original work, and pass an oral examination before a committee of the Department.

Candidates for the Ph.D. will take such courses and meet such requirements as deemed necessary by their advisory committee, must satisfy the foreign language requirements of the Department, must pass a comprehensive written examination prepared by an appropriate Departmental committee and pass the oral examination administered by the Graduate Board of the University, and submit an acceptable dissertation based on original research. A year of residence at the University is required for all advanced degrees.

The following courses in the marine sciences are offered during the regular year at the main campus by the Department of Earth and Planetary Sciences.

| | | |
|------------|------------------------------------|----|
| 27.11-12 | Introduction to the Earth Sciences | 3 |
| 27.301-302 | Problems in the Earth Sciences | 4½ |
| 27.314 | Marine Geology | 5½ |
| 27.331-332 | Marine Ecology | 4½ |
| 27.603 | Advanced Theoretical Oceanography | 4½ |
| 27.605-606 | Waves and Tides | 4½ |
| 27.611-612 | Physical Oceanography | 5 |
| 27.615 | Research Problems in Oceanography | |
| 27.616 | Biological Oceanography | 4½ |
| 27.620 | Advanced Biological Oceanography | 3½ |
| 27.623 | Marine Microbiology | |
| 27.624 | Chemistry of Sea Water | 4½ |
| 27.625 | Advanced Chemical Oceanography | 4½ |
| 27.626 | Estuarine Oceanography | 3 |
| 27.628 | Advanced Wind Wave Theory | 3 |
| 27.630 | Oceanic Turbulence | 3 |
| 27.678 | Carbonates | 5½ |
| 50.311-12 | Introduction to Meteorology | 4½ |
| 50.659-660 | Turbulence | 4½ |

The instructional staff for the courses listed above consists of the following:

Oceanography

Phillips, Owen M., Ph.D., Chairman and Professor of Geophysics
Bricker, Owen P., Ph.D., Assistant Professor of Geology
Carpenter, James H., Ph.D., Associate Professor of Oceanography
Eugster, Hans P., D.Sc., Professor of Geology
Ginsburg, Robert N., Ph.D., Professor of Geology & Oceanography
Hardie, Lawrence A., Ph.D., Assistant Professor of Geology
Kinsman, Blair, Ph.D., Associate Professor of Oceanography
Long, Robert R., Ph.D., Professor of Fluid Mechanics
Marcus, Allan, Ph.D., Associate Professor of Statistics and Earth & Planetary Sciences
Montgomery, Raymond B., Sc.D., Professor of Oceanography
Pettijohn, Francis J., Ph.D., Professor of Geology
Pritchard, Donald W., Ph.D., Professor of Oceanography
Taylor, W. Rowland, Ph.D., Associate Professor of Oceanography
Watson, Geoffrey S., Ph.D., Professor of Mathematical Statistics
Wilson, Simon D. R., Ph.D., Visiting Assistant Professor in Meteorology

To obtain further information, address all inquiries directly to:

Dr. Owen M. Phillips, Chairman
Dept. of Earth and Planetary Sciences
The Johns Hopkins University
Baltimore, Maryland 21218

LEHIGH UNIVERSITY

Bethlehem, Pennsylvania

The University offers marine science and ocean engineering courses on its main campus at Bethlehem, Pa. The Center for Marine and Environmental Studies (CMES), located in Williams Hall on the main campus, is a faculty and graduate research organization, encouraging interdisciplinary research in ocean engineering, marine science and environmental studies. CMES is interdepartmental, and provides opportunities for staff and students from the fields of biology, geology, chemistry and physics, and civil, mechanical and chemical engineering to carry out research on problems of common interest.

The facilities of CMES include: a well-equipped laboratory for microbiological and biochemical research; a laboratory with several circulating temperature-controlled artificial saltwater aquaria; and a well-equipped facility for geotechnical ocean engineering research, including telemetering probes for measuring significant engineering properties of bottom sediments in water depths to 4.5 kms, advanced-design sediment corers, a fine-focus X-ray machine, a gamma-ray transmission densitometer, and a walk-in core refrigerator.

The University Computing Center (CDC-6400 and peripheral equipment) is available for staff and students. Some major items of equipment shared with other departments include: an Applied Research Laboratory electron microprobe, an RCA electron microscope, Norelco X-ray diffractometer, Beckman DU spectrophotometer, Beckman infrared analyzer and carbon train, Coleman nitrogen analyzer, and the facilities of Hydraulics Division of Fritz Laboratory with a variety of flumes, wave tanks, and sedimentation tanks and tables.

Most of the work at sea is done through cooperative programs with Bermuda Biological Station, Duke University, Woods Hole Oceanographic Institution, the Sandy Hook Laboratory of the U. S. Bureau of Fish and Wildlife, the Atlantic Oceanographic Laboratories of ESSA in Miami, and Texas A&M University.

Lehigh is an active member of The Institute for Development of Riverine and Estuarine Systems (IDRES), and maintains the R/V MYSID, a 20-foot shallow draft catamaran for riverine and estuarine research.

The M.S. and Ph.D. degrees are awarded in chemistry, biology, and geology. Graduate options or minors are available in Marine Science, Ocean Engineering, and Water Pollution Control. These and other interdisciplinary programs can be arranged.

General Requirements

Master's Degrees—All students complete satisfactorily at least two full semesters of advanced work. The minimum program for the master's degree must include:

- a. Not less than thirty semester hours of graduate work.
- b. Not less than eighteen hours of "400" level course work.
- c. Not less than eighteen hours in the major field.
- d. Not less than fifteen hours of "400" courses in the major field.

The eighteen hours required in the major field are ordinarily taken in one department. The remaining twelve hours of a minimum program, or any part of them, may also be taken in the major department; or they may be taken in any other field in which courses for graduate credit are offered subject to the approval of the chairman of the major department. In order to qualify for the master's degree, candidates will be required (a) to submit a thesis or a report based on a research course of at least 3 credit hours, and/or (b) to pass a comprehensive examination given by the major department. If required, the thesis shall not count for more than six semester hours.

The master's degree is not granted unless the candidate has earned the grades "A" or "B" in at least eighteen hours of the work of his program. No course in which the grade is earned is less than "C" is credited toward the degree. When all requirements have been met, the candidate is recommended by the faculty to the trustees for the master's degree appropriate to the work pursued.

Doctor of Philosophy—The degree of Doctor of Philosophy is conferred on candidates who have demonstrated general proficiency and high attainment in a special field of knowledge and capacity to

carry on independent investigation in that field as evidenced by the presentation of an acceptable dissertation embodying the results of original research.

A candidate ordinarily is expected to devote three or more academic years to graduate study. Graduate work done in residence at other institutions may be accepted in partial fulfillment of the time requirements. A candidate for the degree must complete at least one full academic year or resident graduate study at Lehigh University.

The student and his faculty advisor are expected to initiate steps for approval of the student's program in the first semester following completion of 30 hours of graduate credit. The department will determine by examinations or other credentials whether the student is qualified.

At the time of application for program approval a special committee is appointed by the Graduate Committee to direct the work of the candidate.

Preparation for the degree is based on the study of a major subject to which one or two minors may be added. The program of work, to be formulated by the candidate, his special committee, and the chairman of his major department, should be planned to lead to a general mastery of the major field and to a significant grasp of any minor that may be added.

The candidate must give evidence, through examinations, of a reading knowledge, sufficient for the purposes of his special studies, of at least two foreign languages. In each case, the required languages are designated by the candidate's major department and approved by the Graduate Committee. In certain fields, the candidate with permission may reduce the requirement to one language appropriate to his field. The qualifying examination in one language must be passed at least twelve (12) months before the candidate applies for his degree.

The general examinations for the doctorate are designed to test both the student's capacity and his proficiency in his field of study and may be both oral and written. They are held not later than seven months prior to the time when the candidate plans to receive the degree.

The candidate is required to present a dissertation prepared under the general direction of a professor at Lehigh University. The dissertation shall treat a topic related to the candidate's major subject, embody the results of original research, give evidence of high scholarship, and constitute a contribution to knowledge. It must be approved by the professor under whose direction it was written, by the candidate's special committee, and by the Graduate Committee.

After the dissertation has been accepted by his special committee, the candidate will be examined orally by the officers of professorial rank in the departments concerned and such other persons as may be selected by the candidate's special committee.

In cooperation with the Center for Marine and Environmental Studies (not an academic department), the Departments of Geological Sciences, Biology, Chemistry, Physics, Civil Engineering, Mechanical Engineering and Mechanics, and Chemical Engineering offer courses during the academic year at the Lehigh campus. Special workshop and practical oceanography courses are offered during the spring in cooperation with the Bermuda Biological Station.

| | | | |
|-----------|--------------------------------------|-----|---|
| Biol. 417 | Marine Ecology | F | 3 |
| Biol. 418 | Biological Oceanography | F | 3 |
| Biol. 480 | Marine Science Seminar | Sp | 1 |
| C. E. 328 | Channel and Oceanographic Hydraulics | Sp | 3 |
| C. E. 332 | Ocean Engineering | Sp | 3 |
| C. E. 425 | Mechanics of Sediment Transport | F | 3 |
| C. E. 4xx | Marine Geotechnique | Sp* | 3 |
| Geol. 363 | Introduction to Oceanography | Sp | 3 |
| Geol. 461 | Marine Geology | Sp | 3 |

The instructional staff for the courses listed above consists of the following:

Department of Geological Sciences

Parks, James M., Ph.D., Director Center for Marine and Environmental Studies and Associate Professor of Geology

MacNamara, E. Everett, Ph.D., Assistant Professor of Geology

*Offered in alternate years.

Department of Geological Sciences—Continued

Richards, Adrian F., Ph.D., Professor of Oceanography and Ocean Engineering

Ryan, J. Donald, Ph.D., Professor of Geology

Schopf, Thomas J. M., Ph.D., Assistant Professor of Geology

Department of Biology

Barber, Saul B., Ph.D., Professor of Biology

Herman, Sidney S., Ph.D., Associate Professor of Biology (at Sandy Hook Marine Laboratory)

Pearce, Jack B., Ph.D., Adjunct Assistant Professor of Biology

Department of Chemistry

Diefenderfer, A. James, Ph.D., Associate Professor of Chemistry

Merkel, Joseph R., Ph.D., Professor of Biochemistry

Department of Chemical Engineering

Coughlin, Robert W., Ph.D., Associate Director CMES, and Professor of Chemical Engineering

Department of Civil Engineering

Adams, John F., Ph.D., Assistant Professor Civil Engineering

Graf, Walter H., Ph.D., Associate Professor Civil Engineering

Richards, Adrian F., Ph.D., Professor of Oceanography and Ocean Engineering

Department of Mechanical Engineering and Mechanics

Stenning, Alan H., Sc.D., Professor of Mechanical Engineering

Terry, Theodore A., Ph.D., Assistant Professor of Mechanical Engineering

To obtain further information, address all inquiries directly to:

Dr. James M. Parks, Director

Center for Marine and Environmental Studies (CMES)

Lehigh University

Bethlehem, Pennsylvania 18015

LONG ISLAND UNIVERSITY (MITCHEL CAMPUS)
East Meadow, New York

The graduate department of marine science consists of three groups: (1) Marine biology, with concentration in marine microbiology, marine biochemistry, and ichthyology, (2) Geophysical sciences, with concentration in physical oceanography and sedimentation, and (3) Technology, with concentration in ocean engineering and instrumentation. Facilities are now located at the Mitchel Center (a branch of C.W. Post-Merriweather Campus) with 26,000 sq. ft. of teaching and research space, and at the Southampton Campus where there is a seaside marina and marine biology laboratory. The Graduate Department operates a 56-foot ocean going motor sailer, the LUCAYO; a 28-foot inshore boat, the ELDON; and several small craft and aircraft. In addition, there is a mobile field laboratory for inshore ecological work.

The University offers the degree of **Master of Science in Marine Science**. Students may specialize in biology, geophysical sciences, or technology.

The following courses are offered in conjunction with this program by the Department of Marine Science:

| | | | |
|-------------|----------------------------------|--------|------|
| MC 501 | Marine Biology | Sp | 3 |
| MC 502 | Marine Biology | Su | 3 |
| MC 608, 609 | Marine Ecology | Sp, Su | 3, 3 |
| MC 610, 611 | Marine Microbiology | | 3, 3 |
| MC 615 | Behavior of Marine Organisms | F | 3 |
| MC 616 | Behavior of Marine Organisms | Sp | 3 |
| MC 621, 622 | Marine Botany | Su | 3, 3 |
| MC 631-632 | Ichthyology | | 4, 4 |
| MC 634 | Marine Invertebrate Zoology | Su | 3 |
| MC 636, 637 | Fisheries Biology | | 3, 3 |
| MC 641, 642 | Biochemistry of Marine Organisms | | 3, 3 |
| MC 643, 644 | Environmental Pollution | | 3, 3 |
| MC 651, 652 | Physical Oceanography | | 3, 3 |
| MC 653, 654 | Field Work in Oceanography | Su | 3, 3 |
| MC 655, 656 | Advanced Physical Oceanography | | 3, 3 |
| MC 657 | Marine Acoustics | F | 3 |
| MC 658 | Marine Acoustics | Sp | 3 |
| MC 659 | Meteorology | F | 3 |
| MC 661 | Marine Geochemistry | F | 3 |
| MC 662, 663 | Marine Sedimentation | | 3, 3 |
| MC 674, 675 | Marine Sanitary Microbiology | | 3, 3 |
| MC 681 | Marine Instrumentation | F | 3 |
| MC 682 | Marine Instrumentation | Sp | 3 |
| MC 691 | Marine Operations | Sp | 3 |
| MC 693, 694 | Ocean Engineering | | 3, 3 |
| MC 695, 696 | Advanced Ocean Engineering | | 3, 3 |
| MC 701, 702 | Marine Science Seminar | | 1, 1 |
| MC 707, 708 | Research and Thesis | | 3, 3 |

The instructional staff for the courses listed above consist of the following:

Freudenthal, Hugo D., Ph.D., Department Chairman
Cahn, Phyllis, Ph.D., Associate Professor, Fish Behavior
Claus, George, Ph.D., Associate Professor, Algae Physiology
Devine, Michael, M.S., Assistant Professor, Oceanography
Freudenthal, Peter, M.S., Adjunct Assistant Professor, Meteorology
Fujiya, Masaru, Ph.D., Research Associate, Fisheries Biology
Hamlin, Norman, M.S., Special Lecturer, Ocean Engineering
Hope, Richard, B.L., Associate Professor, Marine Operation

McIllroy, William Ph.D., Adjunct Associate Professor, Acoustics
Newman, Bernard, Ph.D., Adjunct Associate Professor, Sanitary Microbiology
Price, David, M.S., Assistant Professor, Ocean Engineering
Uzzo, Anthony, M.S., Assistant Professor, Instrumentation
Romer, Harold, M.S., Adjunct Professor, Environmental Engineering
Jones, Jo Ann, Ph.D., Research Associate
Madri, Peter, Research Associate
Siler, William, Research Associate
Greenberg, Chester, Manager of Operations

To obtain further information, address all inquiries directly to:

Dr. Hugo D. Freudenthal, Chairman
Graduate Department of Marine Science
Long Island University, Mitchel Campus
10 Merrick Avenue
East Meadow, New York 11554

LONG ISLAND UNIVERSITY (SOUTHAMPTON CAMPUS)
Southampton, New York

The Division of Natural Sciences instructional, laboratory and research space approximates 20,000 sq. ft. which includes a one acre campus marine station of 3,000 sq. ft. with docking facilities. Vessels owned and operated by the Division include one 28 ft., two 24 ft. and two 17 ft. boats which are equipped for instructional and appropriate research activity. At present larger vessels are chartered.

The B.A. in Marine Science is offered by the Natural Science Division. All marine science majors must take the following courses as prerequisites with division:

Mathematics 1, 2, 101, 102 College math through the calculus.

Physics 1-2 Introductory physics.

Biology 1-2 (General) or Geology 1-2 (General)

Chemistry 1-2 (General), Chemistry 113 (Quantitative Analysis).

All marine science majors must take the marine science sequence: MS 1-2, 110-111, 190, 197-198 (Senior Seminar).

All majors must choose one area of concentration from:

(a) Biological: Biology 101, 103, 180 or 172, MS 141, 110 or 111, Chemistry 111-112 (Organic).

(b) Chemical: Chemistry 111-112, 114, 115-116, Electives (6 credits).

(c) Geological: Geology 101, 103-104, 105-106, 112, 113, 136.

All majors then have to take 10-16 hours electives plus approximately 44-50 hours in the humanities, social science and language.

Courses in the basic areas of biology, chemistry and geology are offered by the appropriate subdivisions of the Natural Science Division. The marine science faculty offers the MS labeled courses at the marine station.

Marine Science Department

| | | | |
|--------------------|--|-------|------|
| Marine Science 1-2 | Introduction to Marine Science | F, Sp | 2, 2 |
| Marine Science 110 | Physical and Chemical Oceanography | Sp | 4 |
| Marine Science 111 | Biological and Geological Oceanography | F | 4 |
| Marine Science 141 | Marine Ecology | Su | 3 |
| Marine Science 190 | Marine Science Summer Program | Su | 6 |

Biology Department

| | | | |
|-------------|----------------------|----|---|
| Biology 101 | Systematic Botany | F | 3 |
| Biology 103 | Invertebrate Zoology | F | 3 |
| Biology 110 | Microbiology | Sp | 3 |
| Biology 111 | Genetics | F | 4 |
| Biology 172 | Plant Physiology | Sp | 3 |
| Biology 180 | Animal Physiology | F | 3 |

Chemistry Department

| | | | |
|----------------|--|-------|------|
| Chemistry 111- | | | |
| 112 | Organic Chemistry | F, Sp | 4, 4 |
| Chemistry 113 | Quantitative Analysis | F, Sp | 4 |
| Chemistry 114 | Instrumental Analysis | Sp | 3 |
| Chemistry 115- | | | |
| 116 | Physical Chemistry for the Life Sciences | F, Sp | 4, 4 |

Geology Department

| | | | |
|--------------|----------------------------------|------------|------|
| Geology 101 | Mineralogy | F | 3 |
| Geology 103- | | | |
| 104 | Sedimentation and Stratigraphy | F, Sp | 3, 3 |
| Geology 105- | | | |
| 106 | Optical Mineralogy and Petrology | Alt. F, Sp | 3, 3 |
| Geology 112 | Meteorology | Alt. F | 3 |

Geology Department—Continued

| | | | |
|-----------------|------------------------------------|--------|----------|
| Geology 113 | Paleontology | Alt. F | 3 |
| Geology 137 | Marine Geology | Alt. F | 3 |
| Natural Science | | | |
| 193-194 | Special Problems in Marine Science | F, Sp | 1-3, 1-3 |

The instructional staff for the courses listed above consists of the following:

Natural Science Division

Burke, W. T., Ph.D., Director of Division and Professor of Biology
Balthaser, L. H., Ph.D., Assistant Professor of Geology; Marine Science
Briles, G. H., Ph.D., Assistant Professor of Chemistry
Coher, E. I., Ph.D., Associate Professor of Biology
Danziger, R., Ph.D., Assistant Professor of Chemistry
Frankenfield, R. K., M.S., Assistant Professor of Marine Science
Haresign, T. W., Ph.D., Associate Professor of Biology
Siegel, A., Ph.D., Associate Professor of Chemistry, Marine Science
Weiss, R. L., Ph.D., Assistant Professor of Geology
Welker, J. R., M.S., Assistant Professor of Marine Science

To obtain further information, address all inquiries directly to:

Admissions Office
Southampton College
Southampton, New York 11968

LOUISIANA STATE UNIVERSITY
Baton Rouge, Louisiana

Louisiana State University is developing a comprehensive program of research, and resource development of the State's coastal marshes, estuaries and gulf waters. Because of the complex environment, the program requires an interdisciplinary approach utilizing interdepartmental capabilities. It is the intent of the University to develop a full-scale capability as a marine institution and to serve this region in all areas of aquaculture and mineral resources. The University has had a cooperative instructional program at the Gulf Coast Research Laboratory, Ocean Springs, Mississippi since 1956. The Department of Zoology and Physiology established its Industrial Research Laboratory, which concentrates on problems of water pollution, in 1958. The University Coastal Studies Institute was organized in 1954 and its staff has had many years' experience in deltaic, marsh, estuarine, and other coastal research on all continents of the world except Antarctica.

Several institutes at the University support programs related to sea research. The Louisiana State Law Institute was established in 1938; more recently, the Institute for Environmental Sciences, Institute for Land Use and Economic Development, Louisiana Water Resources Research Institute, and the Institute for Saline Studies have been established.

The following degrees are offered by the University:

1. No undergraduate degrees are offered in marine sciences. The Bachelor of Science may be taken with major emphasis in related fields.
2. MS in Food Science and Technology, Wildlife and Fisheries, Geography (with concentration in Coastal Geography), Geology, Marine Science (Coastal Physical Oceanography), Zoology.
3. Ph.D. in Food Sciences and Technology, Geography (with concentration in Coastal Geography), Geology, Marine Science (Coastal Physical Oceanography), Zoology.

The following courses are offered in conjunction with the above programs:

Department of Food Science and Technology

| | |
|-----|--------------------------------|
| 143 | Food Technology |
| 144 | Food Technology |
| 182 | Plant Metabolism |
| 190 | Food Enzymes |
| 207 | Food Composition and Analysis |
| 230 | Research in Fisheries Products |
| 271 | Seminar in Food Science |
| 272 | Seminar in Food Technology |
| 300 | Thesis Research |
| 400 | Dissertation Research |

School of Forestry and Wildlife Management

| | |
|-----|------------------------------------|
| 121 | Ichthyology |
| 124 | Fur Animal Management |
| 125 | Limnology |
| 126 | Pond and Stream Management |
| 225 | Advanced Game Management—Waterfowl |
| 230 | Fishery Pathology |
| 232 | Fishery Research Technology |
| 234 | Wildlife Population |
| 300 | Thesis Research |

School of Geology

Department of Geology

| | |
|-----|--------------------------------------|
| 124 | Deltaic Geology |
| 131 | Introduction to Sedimentation |
| 141 | Introductory Geophysics |
| 159 | Introductory Geochemistry |
| 227 | Seminar in Special Phases of Geology |

Department of Geology—Continued

- 233–234 Analysis of Sediments
- 253 Paleoecology

Department of Geography and Anthropology

- 116 Hydroclimatology
- 118 Microclimatology
- 121 Alluvial Morphology
- 175 Transportation
- 177 Economic Geography
- 182 Biogeography
- 184 Paleogeography
- 119 Photo Interpretation
- 120 Photo Interpretation
- 141 Field Geography
- 123 Remote Sensing
- 126 Coastal Environments—Natural
- 127 Coastal Environments—Cultural
- 123 Coastal Morphology
- 124 Deltaic Morphology
- 170 Ethnology of Pacific Basin
- 241 Coastal Ecology
- 242 Coastal Climatology
- 246 Coastal and Estuarian Resources
- 245 Coastal Ethnography
- 221 Research and Field Work
- 223 Research and Field Work

Department of Marine Science

- 216 Coastal and Shallow-Water Literature
- 217 Coastal Swamps and Marshes
- 221 Elements of Geophysical Fluid Dynamics
- 222 Gravity Waves in Shallow Water
- 223 Shore Dynamics
- 224 Form-Process Relationships in Coastal Environments
- 225 Estuarine and Shallow-Water Oceanography
- 226 Coastal Sedimentary Environments
- 231 Geochemistry of Coastal Waters, Soils and Sediments
- 232 Methods of Geochemistry
- 298 Advanced Reading and Literature Research
- 299 Advanced Field Research
- 300 Thesis Research
- 400 Dissertation Research

Department of Microbiology

- 161 Microbiology of Water, Sewage, and Industrial Wastes
- 200 Electron Microscopy of Biological Materials
- 221 Virology

Department of Zoology and Physiology

- 151 Marine Biology
- 153 Animal Ecology
- 154 Invertebrate Zoology
- 236–237 Seminars in Ecology
- 238–239 Seminars in Systematics, Evolution, and Zoogeography
- 297–298 Research
- 300 Thesis Research
- 400 Dissertation Research

The instructional staff for the courses listed above consists of the following:

Allen, R. Scott, Ph.D., Head and Professor of Biochemistry
Avault, James W., Jr., Ph.D., Assistant Professor of Wildlife Management
Amborski, Robert L., Ph.D., Assistant Professor of Microbiology
Baker, John B., Ph.D., Professor of Plant Pathology
Bennett, Harry J., Ph.D., Professor of Zoology & Physiology
Billings, Gale K., Ph.D., Assistant Professor of Geology
Brown, Clair A., Ph.D., Professor of Botany & Plant Pathology
Coleman, James M., Ph.D., Assistant Professor of Coastal Studies Institute, and Department of Marine Sciences
Colmer, Arthur R., Ph.D., Alumni Professor of Microbiology
Culley, Dudley D., Jr., M.S., Assistant Professor of Forestry & Wildlife Management
Ferm, John C., Ph.D., Professor of Geology and Coastal Studies
Ferrell, Ray E., Jr., Ph.D., Assistant Professor of Geology
Gagliano, Sherwood M., Ph.D., Assistant Professor of Coastal Studies Institute, and Department of Geography and Anthropology
Glasgow, Leslie L., Ph.D., Professor of Forestry and Wildlife Management
Gosselink, James, Ph.D., Associate Professor of Botany and Marine Science
Grodner, Robert M., Ph.D., Associate Professor of Food Science and Technology
Harman, Walter J., Ph.D., Professor and Chairman of Department of Zoology and Physiology
Ho, Clara L., Ph.D., Assistant Professor of Coastal Studies Institute; Department of Marine Science
Knight, H. Gary, LLB, Assistant Professor of Law; Department of Marine Science
Lee, Jordan G., Ph.D., Professor of Biochemistry
Lewis, James, Ph.D., Assistant Professor of Geography and Anthropology
Liuzzo, Joseph A., Ph.D., Associate Professor of Food Science and Technology
Loesch, Harold, Ph.D., Professor of Zoology; Department of Marine Science
Lovell, Richard T., Ph.D., Associate Professor of Food Science and Technology
Lowery, George H., Jr., Ph.D., Boyd Professor of Zoology & Physiology and Director of Museum of Natural Science
Lowy, Bernard, Ph.D., Professor of Botany and Plant Pathology
Martinez, Joseph, Ph.D., Professor of Environmental Engineering; Department of Marine Science
McIntire, William G., Ph.D., Professor of Geography and Anthropology, and Coastal Studies Institute; Department of Marine Science
Meyers, Samuel P., Ph.D., Professor of Food Science; Department of Marine Science
Morgan, James P., Ph.D., Professor of Geology
Moore, Clyde H., Jr., Ph.D., Assistant Professor of Geology
Muller, Robert, Ph.D., Associate Professor of Geography and Anthropology
Murray, Stephen P., Ph.D., Assistant Professor of Coastal Studies Institute; Department of Marine Science
Normand, Wilbert C., Ph.D., Assistant Professor of Botany and Plant Pathology
Novak, Arthur F., Ph.D., Professor and Head of Department of Food Science and Technology
Perkins, Robert F., Ph.D., Associate Professor of Geology
Risinger, Gerald E., Ph.D., Assistant Professor of Biochemistry
Rossman, Douglas A., Ph.D., Associate Professor of Zoology and Physiology
Socolofsky, Marion D., Ph.D., Professor and Chairman of Department of Microbiology
Smith, William G., Ph.D., Assistant Professor of Coastal Studies Institute; Department of Marine Science
Sonu, Choule J., Ph.D., Associate Professor of Coastal Studies Institute; Department of Marine Science
Standifer, Leonidas C., Jr., Ph.D., Associate Professor of Plant Pathology
Van Lopik, Jack R., Ph.D., Professor and Chairman of Department of Marine Science

Walker, H. J., Ph.D., Professor of Geography and Anthropology and Coastal Studies Institute
West, Robert, Ph.D., Professor of Geography and Anthropology and Coastal Studies Institute
Williams, Virginia R., Ph.D., Professor of Biochemistry
To obtain further information, address all inquiries directly to:
Dr. Jack Van Lopik, Chairman
Department of Marine Science
Louisiana State University
Baton Rouge, Louisiana 70803

LOUISIANA STATE UNIVERSITY IN NEW ORLEANS
Lake Front, New Orleans, Louisiana

LSU in New Orleans is located on the shore of Lake Pontchartrain from which access to the Gulf of Mexico is afforded by the Intercoastal Waterways, the Mississippi River and connecting bayous and canals. The College of Sciences has a small vessel suitable for estuarine studies which is well equipped with field equipment supported by adequate laboratory-based facilities.

The facilities of the Marine Laboratory located on Grand Terre Island, Louisiana, may be made available upon request through cooperation with the Louisiana Wild Life and Fisheries Commission. These facilities consist of several research vessels and a land-based seawater laboratory located on the Gulf of Mexico. Similarly, the facilities and vessels of the State of Mississippi's Gulf Coast Research Laboratory, Ocean Springs, Mississippi, may be made available upon request. The facilities of the U. S. Department of the Interior at Passagoula, Mississippi, include several fishery research vessels, and may be made available for intermittent periods through cooperative research programs. All of these locations are directly on the Gulf of Mexico within 90 miles of New Orleans.

The LSU System holds charter membership in the Gulf Universities Research Corporation, which is described in the Consortia section of this publication.

No degrees are offered in oceanography, but the bachelors degree is offered in biological sciences, chemistry, earth sciences, engineering sciences and physics; the M.S. degree is offered in biological sciences, chemistry and physics; the Ph.D. degree is offered presently in the Department of Chemistry.

The University considers that specialization in Marine Science should be undertaken within one of the classical scientific disciplines such as biological sciences, chemistry, earth sciences, engineering sciences, and physics. Although undergraduate degrees are offered in these areas, graduate studies rather than undergraduate studies, are emphasized in the interdisciplinary marine sciences program. There is no separate department offering work toward a degree in oceanography. The Committee on Oceanography will assist students who wish to prepare themselves for work in this special field, and will help them arrange a joint program of study when that is desired in any of the above disciplines.

The following courses are offered in conjunction with the above programs:

Department of Biological Sciences

| | | |
|-----|----------------------------|---|
| 116 | Aquatic Microbiology | 4 |
| 117 | Limnology and Oceanography | 4 |
| 150 | General Ecology | 4 |
| 154 | Invertebrate Zoology | 4 |
| 155 | Comparative Physiology | 4 |
| 203 | Malacology | 3 |

Department of Earth Sciences

| | | |
|-----|---|---|
| 166 | Sedimentation and Sedimentary Petrology | 3 |
| 181 | Introduction to Geophysics | 4 |
| 182 | Earth Physics | 3 |
| 185 | Introduction to Oceanography | 3 |

The instructional staff for the courses listed above consists of the following:

Dundee, D. S., Ph.D., Professor of Biological Sciences
Olmsted, C. A., Ph.D., Associate Professor of Biological Science
Otvos, E. G., Ph.D., Assistant Professor of Earth Sciences
Stern, D. H., Ph.D., Assistant Professor of Biological Sciences
Weidie, A. E., Ph.D., Associate Professor of Earth Sciences
Wolleben, J. A., Ph.D., Assistant Professor of Earth Sciences

To obtain further information, address all inquiries directly to:

Dr. Clinton A. Olmsted
Chairman, Committee on Oceanography
College of Sciences
Louisiana State University in New Orleans
Lake Front, New Orleans, Louisiana 70122

UNIVERSITY OF MAINE
Orono, Maine

The university offers marine science courses at both its main campus in Orono and its new marine research station, the Ira C. Darling Center for Research, Teaching and Service, at Walpole. Pertinent facilities on the main campus include a new zoology building with adequate classroom and laboratory facilities for marine sciences research and the University Computing Center which has an IBM 360, Model 30 computer. At Walpole, 100 miles south of the campus, facilities on a 136-acre site include a classroom, well-equipped research laboratories, all-weather living accommodations for 22 students, library, the 43-foot R/V DRAKE and several skiffs with outboards. A pier to provide deep-water docking facilities is under construction. Southern Maine Vocational Technical Institute's 134-foot AQUALAB is available at South Portland for cooperative use.

The University offers the degree of **Ph.D. in Oceanography**. The degree program is administered by the Oceanography Steering Committee in cooperation with the various science departments. At present, only students wishing specialization in biological oceanography will be admitted to the program. A student must apply for admission to one of the biology departments (Bacteriology, Biochemistry, Botany and Plant Pathology or Zoology) and indicate on the application the wish to pursue studies in Biological Oceanography. Acceptance by both the Biology Department and the Oceanography Steering Committee (OSC) is required for admission to the program.

Departmental requirements must be satisfied in addition to those specified by the OSC. The latter include: (1) Zo 170, a prerequisite to all advanced courses in Oceanography, (2) a minimum of one summer, or the equivalent, at a marine station while engaged in an approved marine activity, (3) research experience at sea, (4) preparation of an acceptable thesis, (5) having a minimum of one member of the OSC serve on the student's graduate committee, and (6) a reading knowledge of two foreign languages.

Students wishing to specialize in a marine problem without entering the oceanography curriculum may seek admission to M.S. or Ph.D. programs in one of the science departments.

The following courses in the marine sciences are offered during the academic year at the main campus by the Departments indicated. Problems-type courses and a summer course are offered at the Darling Center.

Department of Botany and Plant Pathology (Bt)

| | | | |
|-----|------------------------|----|---|
| 163 | Introductory Phycology | Sp | 4 |
|-----|------------------------|----|---|

Department of Zoology (Zo)

| | | | |
|----------|--|-------|-------------------|
| 132 | Ichthyology | Sp | 4 |
| 153 | Invertebrate Zoology | F | 4 |
| 168 | Limnology | Sp | 4 |
| 170 | Introduction to Oceanography | Sp | 3 |
| 171 | Fish Management | F | 4 |
| 210 | Marine Invertebrate Zoology | Su | 5 |
| 357 | Population Dynamics | F | 2 |
| 362 | Estuarine Ecology | F | 4 |
| 369 | Introduction to Biological Oceanography | F | 4 |
| 370 | Advanced Topics in Aquatic Biology | Sp | (Credit Variable) |
| 392 | Problems in Zoology (Functional Anatomy of Marine Invertebrates) | Sp | 3 |
| 393, 394 | Problems in Biological Oceanography | Sp, F | (Credit Variable) |
| 399 | Thesis | | |

The instructional staff for the courses listed above consists of the following:

Department of Botany and Plant Pathology

Vadas, Robert L., Ph.D., Assistant Professor of Botany

Department of Geology

Fink, L. Kenneth, Jr., Ph.D., Assistant Professor of Geology

Department of Zoology

Dean, David, Ph.D., Professor of Zoology

Dearborn, John H., Ph.D., Assistant Professor of Zoology

Haefner, Paul A., Jr., Ph.D., Associate Professor of Zoology

Hatch, Richard W., Ph.D., Associate Professor of Zoology

McAlice, Bernard J., Ph.D., Assistant Professor of Zoology

McCleave, James D., Ph.D., Assistant Professor of Zoology

Meyer, Marvin C., Ph.D., Professor of Zoology

To obtain further information, address all inquiries directly to:

The Dean of the Graduate School

University of Maine

Orono, Maine 04473

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Cambridge, Massachusetts

Graduate education in oceanography is carried out as a cooperative effort by the Departments of Earth and Planetary Sciences and of Meteorology, and leads to master's and doctor's degrees in oceanography, geology, geophysics and meteorology. Through a joint degree program in oceanography with Woods Hole Oceanographic Institution the degrees of doctor of philosophy and doctor of science are awarded jointly by both institutions. Normally, students in oceanography at M.I.T. are considered to be in the joint M.I.T.-W.H.O.I. program.

The educational program requires students to become conversant with applied mathematics and other fundamentals, stressing the need for quantitative and deliberate inquiry rather than emphasizing the more routine aspects of oceanography. A student will normally spend his first year or two at M.I.T., and then do his thesis research either at M.I.T. or at Woods Hole, dependent upon location of his advisors and the facilities needed.

Instruction in oceanography is offered by the Departments of Meteorology and of Earth and Planetary Sciences at M.I.T. and by the Woods Hole Oceanographic Institution. Many other M.I.T. departments offer subjects in marine sciences and engineering in addition to subjects basic to oceanography. Thus this section should be read in conjunction with the section of this book on the Woods Hole program and the section on the M.I.T. program in Ocean Engineering.

While M.I.T. maintains a small dock facility in Boston and has a 50 ft. research vessel, used for local observations, instrumentation tests and courses, Woods Hole Oceanographic Institution maintains a fleet of ocean going research vessels with a concomitant shore facilities. In addition, M.I.T. has other extensive facilities—laboratories, classrooms, libraries, computing and data processing services, etc.

In accordance with the program described above, the following degrees are offered:

1. **Ph.D. and Sc.D. in Oceanography** offered by M.I.T. (Department of Earth and Planetary Science and Department of Meteorology)

2. **Ph.D. and Sc.D.** offered jointly by M.I.T. and W.H.O.I. For the doctorate a student is required to pursue a program of advanced study leading to a general examination; to demonstrate ability in research by presentation and defense of a thesis; to meet language requirements (ability to read scientific literature in two acceptable foreign languages, or a more extensive reading and speaking knowledge of one), and certain residence requirements.

3. **Master of Science in Oceanography** offered by M.I.T. alone (Department of Earth and Planetary Sciences, Department of Meteorology). For the master's degree a student must complete an academic program of 66 credit units, of which 42 must be graduate "A" subjects, and a thesis, during at least one year of residence.

The following courses are offered in conjunction with the above programs:

Undergraduate Courses

| | | |
|-------|-------------------------|----|
| 12.09 | Geology III | 12 |
| 12.21 | Physical Oceanography | 12 |
| 19.83 | Physical Oceanography I | 12 |

Graduate Courses

| | | |
|---------------|---|----|
| 12.32 | Sedimentology and Sediment Movement (A) | 12 |
| 12.325 | Sedimentology Seminar (A) | 6 |
| 12.502 | Interpretation Methods in Regional Geophysics | 9 |
| 12.73 | Marine Geodesy (A) | 9 |
| 12.81 | Waves and Tides (A) | 12 |
| 12.815 | Seminar in Physical Oceanography | 9 |
| 12.829 | Research in Chemical Oceanography | 12 |
| 12.891–12.899 | Seminar in Oceanography (A) | |
| 12.901–12.909 | Special Problems in Oceanography | |
| 12.91 | Research in Physical Oceanography (A) | |
| 19.22 | Air and Sea Instruments (A) | 11 |

Graduate Courses—Continued

| | | |
|--------|--|----|
| 19.24 | Fluid Dynamics Laboratory (A) | 8 |
| 19.601 | Introduction to Dynamical Meteorology | 9 |
| 19.62 | Dynamic Meteorology I | 9 |
| 19.64 | Dynamic Meteorology II (A) | 12 |
| 19.65 | Turbulence and Random Phenomena in Fluid Mechanics | 12 |
| 19.67 | Planetary Fluid Dynamics (A) | 12 |
| 19.80 | Surface and Internal Waves (A) | 9 |
| 19.84 | Dynamic Oceanography (A) | 9 |
| 19.86 | Ocean Circulations (A) | 9 |
| 19.87 | Seminar in Physical Oceanography (A) | 9 |
| 19.89 | Special Problems in Oceanography (A) | |
| 19.97 | Special Subject in Oceanography (A) | |

Other Related Courses

Department of Mathematics

| | |
|--------|--|
| 18.60 | Introduction to Fluid Mechanics |
| 18.611 | Rotating Fluids |
| 18.612 | Introduction to Geophysical Fluid Dynamics |
| 18.62 | Hydrodynamic Stability and Turbulence |
| 18.656 | Wave Motion |

Other Departments

| | |
|-------|----------------------------------|
| 1.69 | Waves and Coastal Processes |
| 1.70 | Mechanics of Sediment Transport |
| 2.283 | Fluid Mechanics of Pollution |
| 6.573 | Introduction to Random Processes |

The Institute also offers undergraduate, graduate and professional programs in ocean engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Earth and Planetary Sciences

Press, Frank, Ph.D., Head of Department and Professor of Geophysics
 Biehler, Shawn, Ph.D., Assistant Professor of Geophysics
 Simmons, M. Gene, Ph.D., Professor of Geophysics
 Southard, John B., Ph.D., Assistant Professor of Geology
 von Arx, W. S., Sc.D., Professor of Physical Oceanography, part-time; Regular staff member
 at Woods Hole Oceanographic Institution
 Wunsch, Carl I., Ph.D., Assistant Professor of Oceanography

Department of Meteorology

Houghton, Henry G., S.M., Head of Department and Professor of Meteorology
 Beardsley, Robert C., Ph.D., Assistant Professor of Oceanography
 Charney, Jule G., Ph.D., Professor of Meteorology
 Keily, Delbar P., S.B., Associate Professor of Meteorology
 Mollo-Christensen, Erik L., Sc.D., Professor of Meteorology
 Phillips, Norman A., Ph.D., Professor of Meteorology
 Rhines, Peter B., Ph.D., Assistant Professor of Oceanography
 Starr, Victor P., Ph.D., Professor of Meteorology
 Stommel, Henry M., B.S., Professor of Oceanography

To obtain further information, address all inquiries directly to:

Professor Frank Press, Head
Head of Earth and Planetary Sciences
Room 54-912
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Professor H. G. Houghton, Head
Department of Meteorology
Room ~~54-1712~~
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

UNIVERSITY OF MASSACHUSETTS Amherst, Massachusetts

The Marine Science program presently centers around the classroom, laboratory, and library facilities on the Amherst campus of the University of Massachusetts. In addition, certain staff members now have laboratory use privileges, by arrangement, at the Woods Hole Marine Biological Laboratories and at the Bureau of Commercial Fisheries laboratory in Gloucester, and similar arrangements can be made for appropriate student research projects. The University is presently arranging for its own quarters in the Gloucester area, which will include both a coastal research station and housing facilities. The University maintains a property on Nantucket Island which may be used by arrangement.

The University maintains a number of trailer-transported motor boats for work in coastal waters, and anticipates acquisition of a larger coastal boat. University staff and students participate in research and training cruises on deep sea vessels by arrangement with cooperating institutions, including Woods Hole Oceanographic Institution, University of Rhode Island, and Duke University. It is anticipated that offshore marine work requiring large vessels will continue to be done through such arrangements for at least the next several years. University workers may also serve at sea on a variety of fishing vessels as well as on the research vessel of the Bureau of Commercial Fisheries.

The University offers the degree of Master of Science in Marine Science (thesis required). Students may specialize in any of the following disciplines: Aerospace Engineering, Agricultural Engineering, Botany, Civil Engineering, Geology, Fisheries, Food Sciences, Mechanical Engineering, Microbiology, Zoology.

COURSE WORK IN THE PROGRAM

Every student will take a core of four 3 credit courses:

- a. Physical Oceanography (Geology 655), Mr. Hayes.
- b. Geological Oceanography (Geology 752), Mr. Webb.
- c. Biological Oceanography (Marine Sciences 501), biological staff.
- d. Chemical Oceanography.

In addition, the student takes a minimum of 15 credit hours in the specialty option of his choice (Geology, Botany, Zoology, Fisheries, Food Science and Technology, Marine Microbial Ecology, or Engineering). These may be taken in one or more departments, but with a minimum of 6 of these credits in the student's chosen area. At least 6 credits must be in the 700-900 courses, which may include seminar credits. The individual's particular course of study will be selected in consultation with his advisor, governed by his interests and scientific background.

The student will do a research problem, either as a special problem or as a thesis:

- a. Marine Science 700 (Special problem) up to 6 credits.
- b. Marine Science 800 (Master's thesis), 6-8 credits.

The choice between the thesis and the special problem will be made with regard to the requirements of the department in which the student elects his specialty option. The work will be done under the direct supervision of a faculty member from the department of the student's choice who is himself actively engaged in marine-oriented work, although he need not be a member of the marine sciences committee. The degree candidate must pass a comprehensive written examination on the subject matter of the core curriculum and a qualifying examination in the chosen specialty option similar in general to the qualifying examination which may be required in that department. In some specialty options, the degree candidate must pass the graduate reading examination or its equivalent in one foreign language (French, German, or Russian).

The program is administered by the graduate school through the Marine Sciences Committee, members of which will advise the student.

The following courses are offered in conjunction with the above program. Those courses appropriate to inclusion in the specialty option are identified by an asterisk.

| | |
|--------------------------|---|
| Botany | |
| 501 | Biological Oceanography |
| 521 (221) | Ecology |
| Engineering | |
| 556* | Introduction to Hydrodynamics |
| 559* | Fluid Mechanics of the Oceans |
| 560* | Hydrology |
| 561* | Open Channel Flow |
| 562* | Hydraulic Engineering |
| 700 | Special Problems in Oceanographic Engineering |
| Fisheries Biology | |
| 700* | Special Problems in Wildlife or Fisheries Biology |
| 701* | Seminar in Wildlife and Fisheries Biology |
| 756* | Fisheries Biometrics |
| 757* | Advanced Fisheries Management |
| 565* | Techniques of Fisheries Biology |
| 570* | Ecology of Fishes |
| 572* | Introduction to Marine Fisheries |
| Geology | |
| 655* | Physical Oceanography |
| 752* | Geological Oceanography |
| 756* | Coastal Processes |
| 751* | Sedimentation |
| 723* | Sedimentary Petrology |
| 782* | Petroleum Geology |
| 846* | Cenozoic Stratigraphy |
| 786* | Ground Water Geology |
| 666* | Pleistocene Geology |
| 670* | Geophysics |
| 520* | Lithology |
| 540* | Invertebrate Paleontology |
| 550* | Sedimentology and Stratigraphy |
| Marine Science | |
| 567* | Microbial Ecology of Marine Environment |
| Zoology | |
| 271* | Invertebrate Zoology |
| 302* | Ichthyology |
| 337* | Population and Community Ecology |
| 370* | Comparative Physiology |
| 583* | General Parasitology |
| 660* | General and Cellular Physiology |
| 740* | Advanced Invertebrate Zoology |
| 744* | Helminthology (Biology of Commensalism) |

The instructional staff for the courses listed above consists of the following:

Wilce, Robert T., Ph.D., Associate Professor, Department of Botany; Director, Program of Marine Science
 Andrews, Thomas J., M.S., Associate Professor, Zoology
 Bemben, Stanley M., Ph.D., Assistant Professor, Civil Engineering
 Carver, Charles E., Jr., Ph.D., Professor, Civil Engineering
 Chajes, Alexander, Ph.D., Assistant Professor, Civil Engineering
 Cole, Charles F., Ph.D., Associate Professor, Fisheries Biology
 Colonell, Joseph M., Ph.D., Assistant Professor, Civil Engineering
 Cromack, Duane E., M.S., Assistant Professor, Mechanical and Aerospace Department

Drum, Ryan W., Ph.D., Assistant Professor, Botany
 Dzialo, Frederick J., Ph.D., Associate Professor, Civil Engineering
 Edwards, Dallas C., Ph.D., Assistant Professor, Zoology
 Eldridge, John W., Ph.D., Professor and Head, Chemical Engineering
 Fillo, John, Ph.D., Assistant Professor, Mechanical and Aerospace Department
 Fultz, Sara A., Ph.D., Assistant Professor, Botany
 Hayes, Miles O., Ph.D., Assistant Professor, Geology
 Heronemus, William E. (USN, ret.), M.S., Professor, Civil Engineering
 Hutchinson, Charles E., Ph.D., Associate Professor, Electrical Engineering
 Kirk, Robert S., Ph.D., Associate Professor, Chemical Engineering
 Lenz, Robert W., Ph.D., Associate Professor, Chemical Engineering
 Levin, Robert E., Ph.D., Assistant Professor, Food Science and Technology
 Litsky, Warren, Ph.D., Professor, Agricultural and Industrial Microbiology
 Livingston, Robert B., Ph.D., Professor, Botany
 McGowan, Jon G., Ph.D., Assistant Professor, Mechanical and Aerospace Department
 Miller, Melton M., Jr., Ph.D., Assistant Professor, Civil Engineering
 Monopoli, Richard V., Ph.D., Associate Professor, Electrical Engineering
 Murthy, S. N. B., Ph.D., Visiting Lecturer, Mechanical and Aerospace Department
 Nash, William A., Ph.D., Professor, Mechanical and Aerospace Department
 Nawar, Wassef W., Ph.D., Associate Professor, Food Science and Technology
 Nutting, William B., Ph.D., Professor, Zoology
 Ritter, John E., Jr., Ph.D., Assistant Professor, Mechanical and Aerospace Department
 Roberts, John L., Ph.D., Associate Professor, Zoology
 Roberts, Larry S., Sc.D., Assistant Professor, Zoology
 Russell, Albert G., Ph.D., Assistant Professor, Mechanical and Aerospace Department
 Stumbo, Charles R., Ph.D., Professor, Food Science and Technology
 Webb, Gregory W., Ph.D., Associate Professor, Geology
 Wyse, Gordon A., Ph.D., Assistant Professor, Zoology
 Zahradnik, John W., Ph.D., Professor, Agricultural Engineering

To obtain further information, address all inquiries directly to:

Dr. Gregory W. Webb, Director
 Program of Marine Science
 University of Massachusetts
 Amherst, Massachusetts 01002

UNIVERSITY OF MIAMI
Coral Gables, Florida

The University's Institute of Marine Sciences originated as the Marine Laboratory in 1943. Research facilities include the Radar Meteorological Laboratory at Main Campus, an underwater acoustic-video system in a reef area off the coast of Bimini, a 45-mile underwater acoustic range from Miami to Bimini, and a station on Barbados for study of wind-transported continental materials. The Institute operates an experimental nursery for pink shrimp and pompano at Turkey Point on Biscayne Bay and a field laboratory at Pigeon Key in the Florida Keys for studies of marine biology, calcium carbonate deposition, and mangrove ecology. The Institute also operates two large research vessels and a number of small craft.

The majority of the academic program of the Institute is at the graduate level, although two undergraduate courses are offered. The Institute's graduate program is taught by scientists actively engaged in research. Students normally elect one of the following major subject areas for their specialty: Marine Biology, Functional Biology, Marine Geology and Geophysics, Physical and Chemical Oceanography, Fisheries Sciences, and Atmospheric Science. Students who show research ability and meet the necessary requirements may take part in investigations being carried on as part of the Institute's research program.

M.S. degrees are offered in Marine Biology, Functional Biology, Marine Geology-Geophysics, Physical-Chemical Oceanography, and Atmospheric Sciences. All students are required to complete thirty course credits, a thesis representing original research or critical review of literature on a topic approved by the staff, an examination demonstrating the reading knowledge of a foreign language (French, German, or Russian), and a comprehensive examination covering a general understanding of the major field as well as courses taken.

Ph.D. degrees are offered in Marine Biology, Functional Biology, Marine Geology-Geophysics, and Physical-Chemical Oceanography. All students are required to obtain permission from their advisory committee and petition the Academic Faculty of the Institute to enter the Ph.D. program. The student must spend at least two consecutive semesters beyond the first year's graduate work in full-time study at the University of Miami Institute of Marine Sciences.

At least 36 graduate credits in courses and seminar are required (these may include courses taken for the M.S. degree, excluding thesis credits), plus 24 credits for the Dissertation. Up to 12 credits may be transferred from other institutions if approved. A reading knowledge of two languages is required, and the second language should be completed within one year after entering the Ph.D. program.

The following courses are offered in conjunction with the above programs:

Physical and Chemical Oceanography

| | | | |
|----------|---|-----------------|---|
| 201 | Introduction to Oceanography | F | 3 |
| 202 | Ocean and Laboratory Studies in Oceanography | F | 1 |
| 501 | General Oceanography | F | 3 |
| 502 | Laboratory for Biologists and Geologists | F | 1 |
| 503 | Laboratory for Physical-Chemical Oceanography | F | 1 |
| 510 | Physical Oceanography | Sp | 3 |
| 511 | Geophysical Fluid Dynamics I | F | 3 |
| 512 | Geophysical Fluid Dynamics II | Sp | 3 |
| 520 | Chemical Oceanography | F | 4 |
| 521 | Surface and Colloid Chemistry | F | 2 |
| 522 | Physical Chemistry in the Earth Sciences | Sp | 3 |
| 532 | Radar Meteorology | By announcement | 3 |
| 542 | Time Series Analyses | Sp | 3 |
| 581, 582 | Supervised Projects | F, Sp | 2 |
| 602 | Physical Oceanography Seminar | Sp | 1 |
| 603 | Chemical Oceanography Seminar | Sp | 1 |

Physical and Chemical Oceanography—Continued

| | | | |
|----------|--|-----------------|-----|
| 611 | Oceanic Circulation and Dynamic Oceanography | F | 3 |
| 612 | Waves and Tides | F | 3 |
| 613 | Underwater Acoustics | Sp | 3 |
| 614 | Optical Oceanography | By announcement | 3 |
| 620 | Selected Problems of Chemical Oceanography | By announcement | 4 |
| 631 | Air-Sea Interaction | Alt. F | 3 |
| 671, 679 | Advanced Studies in Physical and Chemical Oceanography | F, Sp | 2–3 |

Marine Geology and Geophysics

| | | | |
|----------|---|-----------------|-----|
| 551 | Marine Geology | F | 4 |
| 553 | Sedimentation | Sp | 4 |
| 554 | Sedimentary Petrology | F | 4 |
| 558 | Geochemistry | Sp | 4 |
| 561 | Geophysics | Sp | 4 |
| 571 | Special Studies | F, Sp | 1–4 |
| 581, 582 | Supervised Projects | F, Sp | 2 |
| 601 | Marine Sciences Seminar | Sp | 1 |
| 605 | Seminar in Marine Geology and Geophysics | F | 1 |
| 621 | Isotopic Processes in Earth Sciences | By announcement | 3 |
| 622 | Analytical Methods in Geochemistry | By announcement | 4 |
| 652 | Carbonate Sedimentation | F | 3 |
| 653 | Advanced Sedimentation | Sp | 4 |
| 654 | Stratigraphic Micropaleontology | Alt. Sp | 4 |
| 655 | Paleoecology | Sp | 3 |
| 661 | Tectonics | Alt. F | 3 |
| 662 | Morphology and Structure of Ocean Basins | Alt. F | 3 |
| 671, 679 | Advanced Studies in Marine Geology and Geophysics | F, Sp | 2–3 |

Marine Biological Science

| | | | |
|----------|--|-----------------|-----|
| 204 | Introduction to Marine Biology | F | 4 |
| 404 | Advanced Marine Biology | Sp | 4 |
| G512 | Phycology | Sp | 4 |
| G531 | Marine Microbiology | Sp | 4 |
| G541 | Marine Biochemistry | By announcement | 4 |
| 602 | Biological Oceanography Seminar | | 1 |
| 604 | General Biological Oceanography | F | 3 |
| 605 | General Biological Oceanography Laboratories | F | 1 |
| 621 | Taxonomy of Marine Invertebrates | Sp | 4 |
| 622 | Ecology of Marine Animals | F, Sp | 4 |
| 623 | Invertebrate Embryology | Sp | 4 |
| 625 | Behavior of Marine Organisms | F | 4 |
| 631 | Plankton | F | 4 |
| 632 | Phytoplankton | Sp | 4 |
| 634 | Physiology of Marine Organisms | F | 4 |
| 671, 679 | Advanced Study in Marine Biological Science | F, Sp | 2–3 |
| 681, 682 | Marine Biological Research | F, Sp | 2 |
| 686 | Biology of Fishes | Sp | 3 |
| 687 | Systematics of Fishes | F | 4 |

Fisheries Sciences

| | | | |
|----------|-------------------------------------|-------|-----|
| G501 | Fishery Biology | F | 4 |
| G502 | Fishery Technology | Sp | 2 |
| G521 | Saltwater Pollution Technology | | 3 |
| 602 | Fishery Seminar | Sp | 1 |
| 604 | Fish Stocks and Their Management | Sp | 4 |
| 605 | Population Enumeration and Dynamics | F | 3 |
| 606 | Ecology of Marine Parasites | Sp | 4 |
| 671, 679 | Advanced Study in Fisheries | F, Sp | 2-3 |
| 681, 682 | Fishery Research | F, Sp | 2 |

Atmospheric Science

| | | | |
|----------|---|-----------------|---|
| 501 | Introduction to Atmospheric Science | F | 3 |
| 511 | Geophysical Fluid Dynamics I | F | 3 |
| 512 | Geophysical Fluid Dynamics II | Sp | 3 |
| 513 | Atmospheric and Oceanic Thermodynamics | By announcement | 4 |
| 518 | Theory of Sensors and Systems | Sp | 3 |
| 521 | Physical Meteorology | Sp | 3 |
| 542 | Statistical Methods in Geophysical Science | By announcement | 3 |
| 571, 574 | Selected Topics in Atmospheric Science | By announcement | 3 |

The University also offers undergraduate and graduate programs in ocean engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Atmospheric Science

Estoque, Mariano, Professor
Geisler, Jack, Assistant Professor
Kraus, Eric, Professor
Latham, Donald, Assistant Professor
Rooth Claes H., Professor

Fisheries Science

Caillouet, Charles W., Associate Professor
Higman, James, Research Scientist
Idyll, Clarence P., Professor
Iversen, Edwin S., Associate Professor
Roessler, Martin A., Assistant Professor
Runnels, Jonnie, Research Scientist
Tabb, Durbin C., Associate Professor
Ward, Benjamin Q., Associate Professor
Yang, Won Tack, Assistant Professor

Marine Biological Sciences

Bayer, Frederick M., Professor
Bunt, John S., Professor
Corcoran, Eugene F., Associate Professor
de Sylva, Donald P., Associate Professor
Fell, Jack, Assistant Professor
Greenfield, Leonard J., Associate Professor
Hughes, David A., Assistant Professor
Lane, Charles E., Professor
Moore, Hilary B., Professor
Myrberg, Arthur A., Associate Professor
Owre, Harding B., Associate Professor

Marine Biological Sciences—Continued

Provenzano, Anthony J., Associate Professor
Reeve, Michael R., Assistant Professor
Richard, Joseph D., Assistant Professor
Robins, Richard, Professor
Smith, Walton F. G., Professor
Stevenson, Robert A., Assistant Professor
Thomas, Lowell P., Assistant Professor
Voss, Gilbert L., Professor
Wood, Ferguson, Professor

Marine Geology and Geophysics

Ball, Mahlon M., Assistant Professor
Bonatti, Enrico, Associate Professor
Bostrom, Kurt G., Associate Professor
Emiliani, Cesare, Professor
Fisher, David E., Associate Professor
Gartner, Stefan, Assistant Professor
Harrison, Christopher G., Associate Professor
Hay, William W., Professor
Hurley, Robert J., Associate Professor
Joensuu, Oiva I., Assistant Professor
Moore, Donald R., Assistant Professor
Nagle, Frederick, Assistant Professor
Neumann, Conrad, Assistant Professor
Niskin, Shale, Research Scientist
Rona, Elizabeth, Senior Research Scientist

Physical and Chemical Oceanography

Bader, Henri, Professor
Bader, Richard G., Professor
Broida, Saul, Assistant Professor
Cratin, Paul D., Associate Professor
Drost-Hansen, Walter, Professor
Duing, Walter, Associate Professor
Gerrish, Harold P., Assistant Professor
Gerchakov, Saul M., Research Scientist
Gordon, Howard, Assistant Professor
Hiser, Homer W., Professor
Millero, Frank J., Assistant Professor
Östlund, Hans Göte, Professor
Prospero, Joseph M., Assistant Professor
Rooth, Claes H., Professor
Senn, Harry V., Associate Professor

To obtain further information, address all inquiries to:

Dr. Robert J. Hurley, Chairman
Division of Graduate Studies in Marine Sciences
Institute of Marine Sciences
10 Rickenbacker Causeway
Miami, Florida 33149

THE UNIVERSITY OF MICHIGAN
Ann Arbor, Michigan

The Department of Meteorology and Oceanography at the University of Michigan includes laboratories for atmospheric turbulence and scintillation research and studies of cloud and precipitation physics, a computer laboratory containing a hybrid analog-digital computer, meteorological instrumentation, and facilities for general, physical and chemical oceanography and submarine geology.

A fleet of three fully-equipped research vessels maintained in the Great Lakes by the Great Lakes Research Division of the University's Institute of Science and Technology are available for staff and student field studies in oceanography. Though the Great Lakes Research Division is a research facility not directly involved in teaching, it has a firm policy of assisting in the educational program through the research of faculty and students.

The University offers the degrees of Ph.D. and M.S. in Oceanography through its Department of Meteorology and Oceanography. An applicant for the degree Doctor of Philosophy in Oceanography is expected to have ability and scholarship of a high order in the fundamentals of the science. In oceanography the fundamentals include the following: macro- and micrometeorology, aquatic ecology, sedimentation and stratigraphy, statics and kinematics, geophysics and geochemistry. An applicant will elect such courses as will, in the opinion of the Graduate Guidance Committee for Oceanography, supplement his background and provide him with the techniques needed to carry out independent investigations.

The student may be required to demonstrate his capability in the fundamentals to the Graduate Guidance Committee by passing one or more qualifying examinations before being recommended as an applicant for the doctorate. Approximately half of the student's course work should be in oceanography, with at least two additional courses, for a minimum of six credit hours in mathematics, physical science, or engineering science.

An applicant may become a candidate for the doctorate upon completion of the course requirements, the preliminary examinations, and the general requirements of the Graduate School, including examinations in one foreign language.

A dissertation fulfilling the requirements of the Horace H. Rackham School of Graduate Studies will be required of each candidate. The subject for the dissertation may be selected from any of the several areas in oceanography. A satisfactory oral examination of the candidate on the dissertation and related material, conducted by the doctoral committee, completes the requirements for the degree.

Requirements for the degree Master of Science in Oceanography include thirty credit hours of graduate studies, approved by one of the graduate advisers, consisting of a minimum of at least fifteen credit hours of course work in oceanography, and a minimum of six credit hours of mathematics or three credit hours of mathematics and three credit hours of physical science or engineering science. Six credit hours of course work in oceanography may, after agreement with the graduate adviser, be replaced by a thesis.

The following courses are offered in conjunction with the above programs:

Undergraduate Courses

| | |
|-----|---|
| 304 | Introduction to Atmospheric and Oceanic Sciences I |
| 305 | Introduction to Atmospheric and Oceanic Sciences II |
| 306 | Laboratory in Geophysical Data I |
| 307 | Laboratory in Geophysical Data II |
| 350 | Ocean Engineering I |
| 351 | Geophysical Fluid Dynamics |

Graduate Courses

| | |
|-----|----------------------------|
| 417 | Geology of the Great Lakes |
| 442 | Ocean Dynamics I |
| 449 | Marine Geology |
| 450 | Ocean Engineering II |
| 478 | Marine Chemistry |

Graduate Courses—Continued

| | |
|-----|--|
| 531 | Marine Ecology |
| 542 | Oceanic Dynamics II |
| 550 | Ocean Engineering III |
| 579 | Atmospheric and Marine Radioactivity |
| 605 | Current Topics in Meteorology and Oceanography |
| 701 | Special Problems in Meteorology and Oceanography |

The University also offers undergraduate, graduate and professional programs in ocean engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Meteorology and Oceanography

Wiin-Nielsen, A. C., Ph.D., Chairman and Professor of Meteorology and Oceanography

Ayers, J. C., Ph.D., Professor of Oceanography

Cole, A. L., Ph.D., Lecturer

Dingle, A. N., Sc.D., Professor of Meteorology

Epstein, E. S., Ph.D., Professor of Meteorology

Gill, G. C., M.A., Professor of Meteorology

Hough, J. L., Ph.D., Professor of Oceanography

Jacobs, S. J., Ph.D., Associate Professor of Oceanography

Kuhn, Wm. R., Ph.D., Assistant Professor of Meteorology

Portman, D. J., Ph.D., Professor of Meteorology

Washington, W. M., Ph.D., Adjunct Associate Professor of Meteorology and Oceanography

Winchester, J. W., Ph.D., Associate Professor of Meteorology and Oceanography

To obtain further information, address all inquiries directly to:

Dr. A. Wiin-Nielsen

Chairman

Department of Meteorology and Oceanography

4072 East Engineering Building

University of Michigan

Ann Arbor, Michigan 48104

NAVAL POSTGRADUATE SCHOOL Monterey, California

The Department of Oceanography offers graduate education in oceanography for naval officers. The oceanography curricula are designed to provide officers with an education in oceanography, with particular application to naval operations, and to enable them through advanced study to conduct independent research. At the present time the Department operates a 63-foot hydrographic research vessel and has modest laboratory facilities ashore. Also utilized are facilities in the Departments of Electrical Engineering, Physics, Mechanical Engineering, and Material Sciences and Chemistry.

The degree of Master of Science in Oceanography (with 3 options) is offered.

Departmental Requirements: Entrance to a program leading to the degree of Master of Science in Oceanography requires a baccalaureate degree in a field appropriate to the oceanography option chosen. Minimal requirements include mathematics through differential and integral calculus, one year of college physics, and one year of college chemistry.

The degree of Master of Science in Oceanography requires:

a. Completion of thirty-five quarter hours of graduate courses of which fifteen hours must be in the 4000 Oceanography series. The entire sequence of courses for the particular option selected must be approved by the Department of Oceanography.

b. An acceptable thesis on a topic approved by the Department of Oceanography.

Objectives of the Options in Oceanography:

Physical and Geophysical—To provide a broad basic education in oceanography, including courses in biological, geological, and chemical oceanography. The core element is physical oceanography. Emphasis is placed upon the application of oceanography to naval operations, and practical experience with instruments and observations.

Operations—To provide the broad spectrum of fundamental principles and information included in the ocean sciences. To improve the capability of solving problems associated with surface and underwater warfare including those involving weapons, search, rescue, recovery, salvage, oceanographic data collection, and the support of emplacements and facilities.

The Department of Oceanography offers the following courses. Marine Science and Engineering courses are also offered in the departments of: Mechanical Engineering, Physics, Electrical Engineering, and Material Sciences and Chemistry. Because new groups of officers begin their curricula both in the spring and in the fall, the majority of the listed courses are offered twice each academic year.

| | | |
|---------|--|-----|
| Oc 0810 | Thesis Research | 0-0 |
| Oc 2110 | Introduction to Oceanography | 3-0 |
| Oc 3150 | Geophysical Random Processes | 4-2 |
| Oc 3221 | Descriptive Oceanography | 4-0 |
| Oc 3250 | Dynamical Oceanography | 4-0 |
| Ph 3250 | Underwater Optics | 3-2 |
| Oc 3260 | Sound in the Ocean | 3-0 |
| Oc 3320 | Geological Oceanography | 3-8 |
| Oc 3420 | Biological Oceanography | 3-3 |
| Oc 3520 | Chemical Oceanography | 3-2 |
| Oc 3601 | Ocean Wave Forecasting | 3-0 |
| Oc 3605 | Ocean Wave Forecasting Laboratory | 0-6 |
| Oc 3611 | Ocean Wave and Surf Forecasting | 2-0 |
| Oc 3615 | Ocean Wave and Surf Forecasting Laboratory | 0-6 |
| Oc 3616 | Oceanographic Forecasting | 3-0 |
| Oc 3621 | Oceanographic Forecasting Laboratory | 0-4 |
| Oc 3700 | Oceanographic Instrumentation and Observations | 3-0 |
| Oc 3710 | Field Experience in Oceanography | 0-4 |
| EE 3731 | Instruments and Equipment for Ocean Operations | 4-3 |
| Oc 3801 | Ocean Operations | 3-1 |

| | | |
|---------|---|-----|
| Oc 4211 | Waves and Tides | 4-0 |
| Oc 4213 | Coastal Oceanography | 4-1 |
| Oc 4251 | Dynamical Oceanography I | 4-0 |
| Oc 4252 | Dynamical Oceanography II | 4-0 |
| Oc 4253 | Dynamical Oceanography III | 3-0 |
| Oc 4260 | Sound in the Ocean | 3-0 |
| Oc 4340 | Marine Geophysics | 3-0 |
| Oc 4421 | Marine Ecology | 1-4 |
| Oc 4422 | Marine Fouling | 1-1 |
| Oc 4612 | Polar Oceanography | 3-0 |
| Oc 4802 | Ocean Operations II | 3-1 |
| Oc 4851 | Geophysics: Earth Gravity | 3-2 |
| Oc 4852 | Geophysics: Earth Magnetism and Electricity | 3-2 |
| Oc 4853 | Geophysics: Sound and Seismicity | 4-0 |
| Oc 4860 | Physics of the Earth | 3-0 |
| Oc 4900 | Seminar in Oceanography | 3-0 |
| Oc 4901 | Seminar in Ocean Operations | 1-0 |

The instructional staff for the courses listed above consists of the following:

Leipper, Dale Frederick, Ph.D., Chairman and Professor of Oceanography
 Andrews, Robert Sanborn, M.S., Assistant Professor of Oceanography
 Boston, Noel Edward James, M.S., Assistant Professor of Oceanography
 Ceres, Robert Lawrence, LCDR, U. S. Navy, M.S., Instructor in Oceanography
 Crew, Henry, M.S., Assistant Professor of Oceanography
 Denner, Warren Wilson, M.S., Assistant Professor of Oceanography
 Geary, Jack Ellsworth, CDR, U. S. Navy, M.S., Assistant Professor of Oceanography
 Giles, Claude F., CDR, U. S. Navy, B.S., Instructor in Oceanography
 Green, III, Theodore, Ph.D., Assistant Professor of Oceanography
 Haderlie, Eugene Clinton, Ph.D., Professor of Oceanography
 Jung, Glenn Harold, Ph.D., Professor of Oceanography
 Smith, Raymond James, Ph.D., Professor of Oceanography
 Thompson, Warren Charles, Ph.D., Professor of Oceanography
 Thornton, Edward Bennett, M.E., Assistant Professor of Oceanography
 Tucker, Stevens Parrington, M.S., Assistant Professor of Oceanography
 von Schwind, Joseph John, Ph.D., Associate Professor of Oceanography
 Wickham, Jacob Bertram, M.S., Associate Professor of Oceanography

To obtain further information, address all inquiries directly to:

Dr. Dale F. Leipper, Chairman
 Department of Oceanography
 Naval Postgraduate School, Code 58
 Monterey, California 93940

UNIVERSITY OF NEW HAMPSHIRE Durham, New Hampshire

Marine science activities at the University are conducted, and degrees granted, within the framework of the fundamental scientific disciplines involving the Science Departments of Biochemistry, Botany, Geology, Microbiology, Physics and Zoology.

The New Hampshire Estuarine Laboratory, constructed in 1969, is located at the junction of Little and Great Bays, approximately five miles from the University at Durham and fifteen miles from the ocean. The Laboratory occupies about 8,400 square feet and contains modern facilities for the Departments of Botany, Biochemistry, Microbiology and Zoology, including a large circulating seawater system and a shop.

The University has skiffs and motored boats suitable for collecting in the estuary. Open ocean work is carried out through arrangements with Woods Hole Oceanographic Institution, Woods Hole, Massachusetts and the Narragansett Marine Station, University of Rhode Island, Kingston, Rhode Island.

The Geology Department's teaching and research facilities are located in a newly renovated building at the University's Durham campus. The proximity of Durham to the Great Bay Estuary, the open-ocean coastal areas of New Hampshire and contiguous states and to the off-shore Isles of Shoals provides easy access to a variety of situations in which marine geological study and research can be conducted.

The Physics Department operates the Underwater Shock-Wave Laboratory, a small scale facility consisting of a 14' x 5' x 4' tank, instrumented with transducers and recording equipment. This facility is being used currently for the study of shock-wave propagation and reflection phenomena from various interfaces as well as shock-wave dissipation in various media.

A Cornell University—University of New Hampshire Summer Program in Marine Science uses facilities at the Isles of Shoals, the Estuarine Laboratory and the University of New Hampshire campus.

The following degrees are offered by the Departments indicated:

1. Master of Science (Departments of Biochemistry, Botany, Geology, Microbiology, Physics and Zoology). For the degree of Master of Science in these departments at least 30 credits must be earned, including a minimum of eight credits in courses, not including thesis.

2. Doctor of Philosophy (Departments of Biochemistry, Botany, Microbiology, Physics and Zoology). The degree of Doctor of Philosophy in these departments is conferred on qualified candidates who have passed an oral or written examination on the subject matter of their field of study, who have completed an original investigation in this field and have embodied the results in an acceptable dissertation, and who have passed an oral examination in defense of the dissertation.

The following courses are offered in conjunction with the above degrees:

| | | |
|-----------------------------------|--|-----|
| Department of Biochemistry | | |
| 895, 896 | Graduate Projects | 1-3 |
| Department of Botany | | |
| 759 | Introduction to Biological Oceanography and Marine Ecology | 3 |
| 780 | Marine Phycology | 4 |
| 880 | Advanced Marine Phycology | 3-4 |
| Department of Geology | | |
| 501 | Introduction to Oceanography | 4 |
| 741 | Geochemistry | 4 |
| 754 | Sedimentation-Stratigraphy | 4 |

Department of Geology—Continued

| | | |
|----------|------------------------------------|-----|
| 759 | Geological Oceanography | 4 |
| 795 | Geological Problems | 2-4 |
| 816 | Mineralogy of Clays | 3 |
| 841 | Analytical Geochemistry | 3 |
| 856 | Estuarine and Marine Sedimentation | 3 |
| 895, 896 | Topics in Geology | 1-4 |

Department of Microbiology

| | | |
|-----|---------------------|------|
| 708 | Marine Microbiology | 4 |
| 899 | Master's Thesis | 6-10 |
| 999 | Doctoral Research | |

Department of Physics

| | | |
|-----|-------------------|---|
| 899 | Master's Thesis | 6 |
| 999 | Doctoral Research | |

Department of Zoology

| | | |
|----------|---|---|
| 701 | Principles of Ecology | 3 |
| 704 | Comparative Endocrinology | 3 |
| 711 | Natural History of Cold-Blooded Vertebrates | 4 |
| 715 | Natural History of Marine Invertebrates | 4 |
| 803 | Marine Ecology | 4 |
| 820, 821 | Invertebrate Zoology | 4 |
| 822 | Protozoology | 4 |
| 823 | The Host-Parasite Relationship | 3 |
| 826 | Comparative Physiology | 4 |
| 830 | Invertebrate Embryology | 4 |

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Biochemistry

Herbst, Edward J., Ph.D., Professor and Chairman of Biochemistry
Green, D. MacDonald, Ph.D., Professor of Biochemistry
Ikawa, Miyoshi, Ph.D., Professor of Biochemistry
Klippenstein, Gerald L., Ph.D., Assistant Professor of Biochemistry

Department of Botany

Mathieson, Arthur C., Ph.D., Assistant Professor of Botany

Department of Geology

Tischler, Herbert, Ph.D., Professor and Chairman of Geology
Anderson, Franz E., Ph.D., Assistant Professor of Geology
Gaudette, Henri E., Ph.D., Assistant Professor of Geology

Department of Microbiology

Slanetz, Lawrence W., Ph.D., Professor and Chairman of Microbiology
Chesbro, William R., Ph.D., Professor of Microbiology
Jones, Galen E., Ph.D., Professor of Microbiology and Director of the Jackson Estuarine

Laboratory

Metcalf, Theodore G., Ph.D., Professor of Microbiology

Department of Physics

Hall, Harry H., Ph.D., Professor of Physics
Clark, David C., Ph.D., Associate Professor of Physics

Department of Zoology

Wright, Paul A., Ph.D., Professor and Chairman of Zoology
Borror, Arthur C., Ph.D., Associate Professor of Zoology
Bullock, Wilbur L., Ph.D., Professor of Zoology
Crocker, Robert A., Ph.D., Assistant Professor of Zoology

Department of Zoology—Continued

Milne, Lorus J., Ph.D., Professor of Zoology

Sasner, John J., Ph.D., Assistant Professor of Zoology

Sawyer, Philip J., Ph.D., Associate Professor of Zoology

Swan, Emery F., Ph.D., Professor of Zoology

Tillinghast, Edward, Ph.D., Assistant Professor of Zoology

To obtain further information, address all inquiries directly to:

Office of Marine Science and Technology

Kingsbury Hall

University of New Hampshire

Durham, New Hampshire 03824

CITY UNIVERSITY OF NEW YORK New York, New York

The University consists of nine senior and eight junior colleges. Classwork and research space are offered at some of the individual campuses. Through joint appointments, mainly in biological oceanography, additional research space is available at the Lamont-Dougherty Geological Observatory. Students and staff will have access to our 100-foot vessel specially equipped for estuarine and near-shore studies. More extensive oceanic work is possible through CONRAD and VEMA (Lamont-Dougherty Geological Observatory) and EASTWARD (National Science Foundation and Duke University). Special arrangements can also be implemented at a variety of local and sub-tropical research institutions. Facilities of the City University also include mobile field laboratory, working skiff, small launch, combined library holdings of nearly 2 million books and 8,000 periodicals, and assorted computers (an IBM 7040, four IBM 1620's, and an IBM 360-50). (All marine facilities are available to other institutions in the New York, New Jersey and Connecticut area.)

The University offers the following degrees in marine science fields through the departments indicated:*

1. **B.S. in Oceanography, Interdisciplinary Group in Oceanography.** This degree is available only at the City College. Students are required to complete 128 credits with an average of "C" or better. In meeting this standard, students: (a) must take a minimum of 44 credits outside their major subject and a minimum of 36 credits in their major, (b) are unlimited in what they take to meet a maximum of 48 credits as free electives, (c) may take up to 16 credits of non-major study on a pass-fail basis, and (d) must select an approved program of study in an oceanographic discipline.

2. **M.A. in Biology, Chemistry, Geology, Physics, Departments of Biology, Chemistry, Geology, Physics.** Generally speaking, the student must: (a) complete 30 credits in an approved program of study with an average grade of "B" or better, (b) demonstrate a reading knowledge of one foreign language and (c) present an original monograph or additional laboratory research credits. Students in Biology and Chemistry must pass a comprehensive examination.

3. **Ph.D. in Biology, Chemistry, Physics, University Committees in Biology, Chemistry, Physics.** Of the generally 60 credits required for the degree, only students studying chemical oceanography would be required to take a specific array of courses (Advanced Inorganic Chemistry, Advanced Organic Chemistry, Quantum Chemistry, Chemical Thermodynamics and Basic Laboratory Techniques for Research). All students are required to complete an approved program of study and to pass a First Examination (comprehensive) and a Second Examination (special field). A dissertation is required in all programs. Only Biology and Chemistry require the student to demonstrate a reading knowledge of two foreign languages. These same two University Committees require that their students display competence in college teaching.

Undergraduate courses are offered to qualified residents of New York State on a nominal or free basis. Graduate programs are open to qualified applicants whether residents of New York State or not. Marine geology is centered at Queens College; marine biology at the City College. Students are not limited to taking courses at their own campus. Some graduate and undergraduate marine courses are offered in the summer, but realistically a student should presume courses leading to a degree only during the regular year. Oceanographic training at all levels is accomplished through special course work added to the usual science and engineering departments.

The following courses are offered by the University by the departments indicated in conjunction with the University's degree programs:

| Biology | | | |
|----------------|--------------------------|-------|---|
| 111 | Biology of Vertebrates | F, Sp | 4 |
| 112 | Biology of Invertebrates | F, Sp | 4 |
| 216 | Principles of Ecology | F, Sp | 2 |
| 221 | Lower Plants | F | 4 |
| 274 | Biological Oceanography | Sp | 4 |

*A Ph.D. in Geology is proposed for the 1969-70 academic year.

Biology—Continued

| | | | |
|------------------|---|-------|------------|
| 293 | Senior Seminar | F, Sp | 2 |
| 298 | Independent Study. Honors. | F, Sp | Usually 4 |
| 301–304 | | | |
| 762, .1 | Physiological Ecology | * | 3 |
| 761.1, .2 | Marine Plankton Dynamics | * | 3 |
| 761.3, 4 | Marine Benthos | * | 3 |
| 761.7, .8 | Marine Microbiology | * | 3 |
| 761.9 | Marine Ecology | * | 4 |
| 790.63 | Seminar In Biological Oceanography | Sp | 3 |
| 791 | Colloquium | F, Sp | 1 |
| 792 | Tutorial | F, Sp | 4 |
| 899 | Independent Doctoral Research | F, Sp | Max 10 |
| Chemistry | | | |
| 12 | Inorganic Chemistry | F, Sp | 4 |
| 30–33 | Physical Chemistry, I and II | F, Sp | 10 Total |
| 46 | Chemical Instrumentation | F, Sp | 4 |
| 55–56 | Organic Chemistry, I and II | F, Sp | 10 Total |
| 59 | Biochemistry | F, Sp | 4 |
| 99.301–304 | Independent Study. Honors | F, Sp | 4–16 |
| 710 | Advanced Inorganic Chemistry | * | 3 |
| 750, 751 | Advanced Organic Chemistry I and II | F | 3 |
| 760 | Introductory Quantum Chemistry | Sp | 3 |
| 810.1–.4 | Doctoral Research | F, Sp | (Variable) |
| Geology | | | |
| 27, 28 | Structural Geology I and II | † | 4 each |
| 21 | Invertebrate Paleontology | Sp | 4 |
| 25 | Sedimentation and Sedimentary Petrography | F | 2 |
| 30, 31 | Stratigraphy I, II | † | 4 each |
| 32 | Petrology | F, Sp | 4 |
| 37 | Geochemistry of Minerals | F | 4 |
| 38 | Petrographic Mineralogy | Sp | 4 |
| 61 | Introduction to Geophysics | F | 4 |
| 64 | Physical Oceanography | F, Sp | 4 |
| 65 | Marine Geology | F | 4 |
| 70 | Field Geology | | 4 |
| Physics | | | |
| 9, 10 | Mechanics | F, Sp | 4 each |
| 13 | Thermodynamics | F, Sp | 4 |
| 55 | Physical Meteorology | Sp | 4 |
| 56 | Dynamic Meteorology | F | 4 |

The instructional staff for the courses listed above consists of the following. Unless otherwise indicated, all staff are based at the City College.

University Committee in Oceanography

Posner, Gerald S., Ph.D., Executive Officer for Oceanography and Associate Professor of

Biology

Donn, William L., Ph.D., Professor of Geology

Lee, John J., Ph.D., Associate Professor of Biology

McIntyre, Andrew, Ph.D., Assistant Professor of Geology, Queens College

Thurber, David, Ph.D., Associate Professor of Geology, Queens College

Tietjen, John H., Ph.D., Assistant Professor of Biology

*Offered in Alternate Years.

†Offered in Alternate Semesters.

Biology

Brody, Marcia, Ph.D., Associate Professor of Biology, Hunter College
Goldstein, Solomon, Ph.D., Associate Professor of Biology, Brooklyn College
Hecht, Max, Ph.D., Professor of Biology, Queens College
Koulish, Sasha, Ph.D., Assistant Professor of Biology, Richmond College
Lee, John J., Ph.D., Associate Professor of Biology
Pierce, Stanley, Ph.D., Assistant Professor of Biology, Queens College
Posner, Gerald S., Ph.D., Associate Professor of Biology
Rachlin, Joseph, Ph.D., Instructor of Biology, Lehman College
Roels, Oswald, Ph.D., Adjunct Professor of Biology
Sacks, Martin, Ph.D., Associate Professor of Biology
Shields, Robert W., Ph.D., Assistant Professor of Biology
Tavolga, William N., Ph.D., Professor of Biology
Tietjen, John H., Ph.D., Assistant Professor of Biology

Chemistry

Barrett, Edward, Ph.D., Assistant Professor of Chemistry, Hunter College
Blei, Ira C., Ph.D., Assistant Professor of Chemistry, Richmond College
Haines, Thomas H., Ph.D., Associate Professor of Chemistry
Soloway, Saul, Ph.D., Associate Professor of Chemistry
Wiley, Richard H., Ph.D., Professor of Chemistry, Hunter College

Geology

Burckle, Lloyd, M.S., Lecturer in Geology, Hunter College
Coch, Nicholas, Ph.D., Assistant Professor of Geology, Queens College
Donahue, Jack, Ph.D., Assistant Professor of Geology, Queens College
Donn, William L., Ph.D., Professor of Geology
Fagan, John, Ph.D., Assistant Professor of Geology
Feeley, Herbert, Ph.D., Associate Professor of Geology, Queens College
Habib, Daniel, Ph.D., Assistant Professor of Geology, Queens College
Krinsley, David, Ph.D., Professor of Geology, Queens College
Loring, Arthur, Ph.D., Assistant Professor of Geology, York College
McIntyre, Andrew, Ph.D., Assistant Professor of Geology, Queens College
Mencher, Ely, Ph.D., Professor of Geology
Newman, Walter S., Ph.D., Assistant Professor of Geology, Queens College
Schaffel, Simon, M.S., Lecturer in Geology
Thurber, David, Ph.D., Associate Professor of Geology, Queens College

Meteorology

Ehrlich, Albert, Ph.D., Associate Professor of Geology
Rommer, Richard, M.S., Lecturer in Geology
Stolov, Harold, Ph.D., Associate Professor of

Physics

Brown, M. Vertner, Ph.D., Professor of Physics
Guthrie, Albert, Ph.D., Professor of Physics, Brooklyn College
Thorndike, Edward, Ph.D., Professor of Physics, Queens College

To obtain further information, address all inquiries directly to:

Dr. Gerald S. Posner
Executive Officer for Oceanography
The City College
Convent Avenue and 138th Street
New York, New York 10031

THE MARITIME COLLEGE OF THE STATE UNIVERSITY OF NEW YORK New York, New York

The college offers marine science courses at its main campus at Fort Schuyler as well as aboard the training ship, the EMPIRE STATE IV. The five-story Science Wing (Marvin Hall) in the new Science and Engineering Building accommodates the various laboratories of the College's Science Department. The Digital Computer Laboratory on the first floor is equipped with an IBM-1130 Digital Computer (including a card-reader-punch and a printer), key punches, card sorter and various types of desk calculators.

The two-story Nuclear Reactor Laboratory, and the Advanced Physics Laboratory, on the first floor, are designed for experiments in Atomic, Nuclear and Reactor Physics. The facilities of the Nuclear Reactor Laboratory include a Nuclear Reactor Simulator that reproduces the control and operation functions of a nuclear power reactor, a sub-critical water-moderated reactor assembly loaded with 6,000 lbs. of natural uranium which permits experimental studies of neutrons and their properties, a neutron pulse generator, a neutron howitzer, a gamma ray spectrometer, a multichannel analyzer with linear display, and a variety of nuclear radiation detection and counting equipment.

The Meteorology Laboratory, Weather Station and lecture area occupy the entire top floor. The roof is designed as an observation deck and provides instrumentation and facilities for the instruction of an entire class in recording weather data. A 40-foot steel tower supports weather instruments which read out to indicators in the classroom and laboratory. Teletype and facsimile machines provide weather data from all of North America and ships at sea. Students plot and analyze weather maps and prepare forecasts.

The R. J. Reynolds Planetarium in the fort houses the model A-1 Spitz projector. A series of three-dimensional models is used to explain the intrinsic structure of the universe as well as its apparent configuration to a terrestrial observer.

An Astronomical Observatory on the roof of the fort was completed in July 1965. The 16 foot 6 inch true hemispherical dome is electrically controlled, while the transverse shutters, offering a 48-inch clear opening, are operated through a torque converter. Both visual and photographic work can be pursued at the observatory.

The EMPIRE STATE IV, the former USNS HENRY GIBBINS of the Military Sea Transportation Service, was built in Ingall's Shipyards, Pascagoula, Mississippi, in 1943. She served as a troop transport during World War II and on MSTs routes until assigned to the Maritime College in December, 1959. The modified C-3 has accommodations for 340 cabin passengers and 740 troops. The 12,000-ton ship is 489 feet in length, with a beam of 69 feet. Her geared steam turbine develops 8500 horsepower and a cruising speed of 16 knots.

During the academic year, the training ship is berthed at Fort Schuyler. Facilities are available on board for laboratory sessions in marlinespike seamanship, marine engineering, communications and electronic aids to navigation. During the summer months, the ship is steamed on the annual training sessions across the Atlantic.

The Oceanography Laboratory aboard the EMPIRE STATE IV offers students the opportunity during the Summer Atlantic cruises to utilize deep sea oceanographic gear. Instruction is provided in the use of: Nansen bottles, reversing thermometers, bathythermographs, infrared thermometers, inductive salinometers, current meters, and turbidity meters, as well as radiosonde and pilot balloon instrumentation.

The 600-foot College Pier provides convenient and adequate docking space for the EMPIRE STATE IV. A boat shed adjacent to the pier is used to house and to launch and retrieve the small boats. A tidal gauge station is situated close to the pier. The basin inshore of the pier is used for mooring the racing sloops and recreational sailing craft of the college.

The course of studies in the Meteorology and Oceanography curriculum includes the practical and theoretical nautical training prerequisite for licensed deck officers together with a complete series of courses designed to provide a thorough understanding of the fundamental principles underlying the sciences of meteorology and oceanography. Combined with the professional work, cadets will pursue courses in the humanities and social sciences that are of importance in the liberal education of youth.

Theory and practice are integrated by relating the scholastic efforts of the academic year to those of the Summer Sea Training Period on the college training ship during the summer months.

The cadets who successfully complete the courses required by this curriculum receive the degree of Bachelor of Science (Meteorology and Oceanography) and, after passing the required U. S. Coast Guard examinations, a Federal license as Third Mate in the Merchant Marine, and if acceptable can obtain a commission as Ensign in the U. S. Naval Reserve.

The curriculum for cadets majoring in Marine Nuclear Science includes an extensive preparation in mathematics, physics, chemistry and metallurgy as well as in the humanities and social studies. The complete set of courses is designed to establish a firm foundation for a professional career in the immediate and foreseeable future. The individual courses have been designed to prepare cadets for the professional duties involved in operation, research and development of nuclear energy, as well as to prepare them in the necessary practical nautical training required to become licensed ship officers.

Cadets who successfully complete the course of studies in this major receive the registered and accredited degree of Bachelor of Science (Marine Nuclear) and are eligible to take the Third Engineer's U. S. Coast Guard operating engineer's license examination; and, if acceptable to the U. S. Navy, they can obtain an Ensign's commission in the U. S. Naval Reserve.

The following courses are offered in conjunction with the above programs:

Meteorology

| | | |
|------|-----------------------------|---|
| 202 | General Meteorology | 3 |
| 305 | Synoptic Meteorology I | 3 |
| 306E | Synoptic Meteorology II | 3 |
| 310 | Dynamic Meteorology I | 3 |
| 311 | Meteorology for Mariners | 3 |
| 411 | Dynamic Meteorology II | 3 |
| 422E | Weather Forecasting | 3 |
| 423E | Thesis | |
| 432E | Applied Meteorology | 3 |
| 442E | Research | |
| 452 | Instruments | 3 |
| 454 | Meteorological Observations | 1 |

Oceanography

| | | |
|------|---------------------------|---|
| 303 | General Oceanography I | 3 |
| 304E | General Oceanography II | 3 |
| 305 | Oceanographic Instruments | 3 |
| 406 | Applied Oceanography | 3 |
| 410E | Oceanography | 3 |
| 413 | Dynamic Oceanography I | 3 |
| 414E | Dynamic Oceanography II | 3 |

The College also offers undergraduate programs in ocean engineering and the training of seagoing officers which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Science

Meir H. Degani, Sc.D., Chairman and Professor of Physics
 Alvin E. Kinney, Ed.D., Executive Officer and Professor of Mathematics
 Meyer Bouscher, M.S., Instructor of Mathematics
 Vito Cifichiello, M.S., Associate Professor of Physics
 David Epstein, Ph.D., Associate Professor of Oceanography
 Fred C. Hess, Ed.D., Professor of Chemistry
 Salomon E. Liverhant, M.S., Professor of Physics
 Joseph D. Longobardi, M.S., Associate Professor of Physics
 George McGinn, Ph.D., Assistant Professor of Physics
 Peter M. Perry, A.B., Technical Specialist

Department of Science—Continued

Joseph J. Pescatore, Ph.D., Assistant Professor of Chemistry

Ellis J. Rich, M.S., Instructor of Mathematics

Jay R. Schwartz, M.A., Assistant Professor of Mathematics

Vincent L. Teofilo, MNE, Instructor of Physics

Charles Thor, M.S., Associate Professor of Meteorology

Stephen G. Tolchin, M.S., Instructor of Physics

Hersh Zemel, M.S., Assistant Professor of Meteorology

To obtain further information, address all inquiries directly to:

Dr. M. H. Degani

Chairman, Science Department

State University of New York Maritime College

Fort Schuyler

New York, New York 10465

NEW YORK UNIVERSITY
Bronx, New York

Current research projects include studies of ocean waves, air-sea boundary processes, solar radiation balance, turbulent dye diffusion, large scale ocean circulation, and the equatorial Atlantic. Extensive analogue and digital computing facilities such as an IBM 360/30, BECKMAN 210, and smaller units are available. A sixty-five foot research ship, the KYMA, equipped with AC and DC power, radar, loran, gyrocompass, fathometer, Doppler navigator, deep sea winch, BT winch, dye diffusion gear, skin diving equipment, and data telemetry electronics is used for oceanographic investigations.

The following degrees are offered in Marine Science:

1. Ph.D. (Department of Meteorology and Oceanography). At least 60 of the 72 required credits must be in meteorology, oceanography, physics, mathematics, or chemistry, and, of these 60 credits, at least 42 must be in meteorology and oceanography. Students whose major interest is meteorology are expected to acquire a basic knowledge of physical and dynamical oceanography. Students whose major interest is oceanography are expected to acquire a basic knowledge of meteorology. The program of each student is subject to approval by his adviser.

A reading knowledge of any one of the following languages is required: German, French, Japanese, Russian; in certain cases another foreign language may be substituted on petition by the student.

Qualifying examinations in physics and mathematics are to be taken as early as possible in order to qualify students to take courses beyond the Master's level.

A student who has spent at least one year in residence, who has either passed a foreign language proficiency test or is registered in a course in an appropriate foreign language, and has passed qualifying examinations in mathematics and physics, may apply to the Department Chairman for admission to **provisional candidacy** for the Ph.D. degree. The student is then assigned to a faculty committee with whom he meets regularly for guidance and demonstration of his potentiality as a doctoral candidate. The committee determines, after about one academic year, whether the student is to be accepted as a candidate for the Ph.D. degree.

The doctoral dissertation is a scholarly presentation of the candidate's original research on a problem of importance in meteorology or oceanography; 6 credits are granted upon acceptance of the dissertation in either T69.3305-3306 or T69.3309-3310. The final general examination will comprise topics in the field of the candidate's dissertation.

2. M.S. in Oceanography or Meteorology (Department of Meteorology and Oceanography). For the Degree of Master of Science: a minimum of 36 credits of which 24 must be in the Department is required. Also required is a paper, suitable for publication, according to either of two alternative plans, the choice of which is made by the student with the permission of his adviser:

Plan A. An acceptable research thesis demonstrating the student's ability to attack and solve a scientific or technical problem, for which a maximum of 6 credits will be granted by registration in T69.2307 for two terms.

Plan B. An essay consisting of a critical review of the literature in a selected area of meteorology or oceanography, for which a maximum of 3 credits will be granted by registration in either T69.2304 or T69.2308.

3. B.S. in Meteorology and Oceanography (Department of Meteorology and Oceanography). The curriculum leading to a B.S. degree includes intensive study in mathematics and physics, and the basic courses in physical, descriptive, and dynamic meteorology and oceanography.

The following courses are offered in conjunction with the above programs:

| | | | |
|-------------|--|-------|---|
| T69.0030-40 | Introduction to the Geophysical Sciences | F, Sp | 8 |
| T69.0050-60 | Dynamic Meteorology and Oceanography | F, Sp | 6 |
| T69.0051-61 | Descriptive Meteorology and Oceanography | F, Sp | 6 |
| T69.0071 | Theoretical Geophysics | F | 3 |
| T69.0077 | Oceanography I | F | 3 |
| T69.0087 | Oceanography II | Sp | 3 |

| | | | |
|---------------|--|-----------|---|
| T69.0080 | Statistical Methods in the Geophysical Sciences | F | 3 |
| T69.1102 | Principles of Meteorological and Oceanographic Instruments | F | 3 |
| T69.1103-1104 | The Planet Earth | F, Sp | 6 |
| T69.1107 | Statistical Methods in Meteorology and Oceanography | Sp | 3 |
| T69.1151-1152 | Physical Oceanography | F, Sp | 6 |
| T69.1701 | Air Pollution Chemistry | F | 3 |
| T69.1702 | Air Pollution Analysis | Sp | 3 |
| T69.2201-2202 | Weather Analysis | F, Sp | 6 |
| T69.2203-2204 | Dynamic Meteorology | F, Sp | |
| T69.2206 | Atmospheric Radiation | Sp | 3 |
| T69.2207-2208 | Atmospheric and Oceanic Turbulence | F, Sp | 6 |
| T69.2211-2212 | Weather Prediction | F, Sp | 6 |
| T69.2217-2218 | Special Topics in Meteorology | F, Sp | 6 |
| T69.2219-2220 | Physics of the Upper Atmosphere | F, Sp | 6 |
| T69.2221 | The Atmospheres of the Planets | F | 3 |
| T69.2224 | Radiometeorology | Sp | 3 |
| T69.2225-2226 | Geophysical Hydrodynamics | F, Sp | 6 |
| T69.2230 | Meteorological Measurements by Rockets and Satellites | Sp | 3 |
| T69.2235-2236 | Atmospheric Chemistry and Radioactivity | F, Sp | 6 |
| T69.2237-2238 | Atmospheric Physics | F, Sp | 6 |
| T69.2239 | General Circulation of the Atmosphere | F | 3 |
| T69.2251 | Special Topics in Oceanography | F | 3 |
| T69.2256 | Analysis and Forecasting of Ocean Waves | Sp | 3 |
| T69.2258 | Selected Problems in Oceanography | Sp | 3 |
| T69.2261-2262 | Oceanographic Field Research | F, Sp, Su | 6 |
| T69.2263-2264 | Analysis of Oceanographic Data | F, Sp, Su | 6 |
| T69.2267 | Oceanography for Engineers I | F | 3 |
| T69.2268 | Oceanography for Engineers II | Sp | 3 |
| T69.2269 | Oceanography and Space Technology | F | 3 |
| T69.2270 | Electromagnetic Properties of Sea Water | Sp | 3 |
| T69.2272 | Transmission of Sound in Sea Water | Sp | 3 |
| T69.2303 | Research Methods in Meteorology and Oceanography | F | 3 |
| T69.2304 | Research in Meteorology | F &/or Sp | 3 |
| T69.2307 | Research for the Master's Thesis | F &/or Sp | 3 |
| T69.2308 | Research in Oceanography | F &/or Sp | 3 |
| T69.2727 | Microclimate and Dispersion of Pollutants | Sp | 3 |
| T69.2749 | Air Pollution Engineering Control | Sp | 3 |
| T69.2766 | Air Pollution Effects | Sp | 3 |
| T69.3305-3306 | Advanced Research in Meteorology | F &/or Sp | 6 |
| T69.3309-3310 | Advanced Research in Oceanography | | 6 |

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Meteorology and Oceanography

Miller, James E., M.S., Chairman and Professor of Meteorology

Neumann, Gerhard, Dr. Rer. Nat., Professor of Oceanography

Pierson, Willard J., Jr., Ph.D., Professor of Oceanography

Department of Meteorology and Oceanography—Continued

Schotland, Richard M., Sc.D., Professor of Meteorology

Spar, Jerome, Ph.D., Professor of Meteorology

Friend, James P., Ph.D., Associate Professor of Atmospheric Chemistry

Ooyama, Katsuyuki, Ph.D., Associate Professor of Meteorology

Kirwan, Albert D., Jr., Ph.D., Associate Professor of Oceanography

Deland, Raymond J., Ph.D., Research Associate Professor of Meteorology

Posmentier, Eric S., Ph.D., Assistant Professor of Oceanography

Cardone, Vincent J., M.S., Lecturer in Meteorology

To obtain further information, address all inquiries directly to:

Chairman, Department of Meteorology and Oceanography

School of Engineering and Science

New York University

University Heights

Bronx, New York 10453

NORTH CAROLINA STATE UNIVERSITY

Raleigh, North Carolina

Marine science courses and related studies are offered on the Raleigh campus and at the following off-campus facilities:

1. The Pamlico Marine Laboratory is a newly established facility near Aurora, North Carolina. The primary research interests encompass the effects of man's activities on the estuarine and marine environment. Current research programs include a study of estuarine circulation using Rhodamine B dye, phosphorus cycling in an estuary in relation to a phosphate mining development, macro- and micro-distribution of zooplankton, benthic invertebrate production and distribution, phytoplankton studies including primary productivity and the determination of algal nutrient requirements, a study of bacterial heterotrophy in estuaries, and the physiological effects of fluorides on invertebrates and aquatic plants. The physical facilities include three laboratory buildings, a dormitory and various research vessels, the largest of which is a 35-foot shrimp trawler. One building is furnished with two salt water flow-through systems for the maintenance and culture of estuarine organisms. Two large walk-in coolers are also available for temperature and photoperiod control. Six one-half acre ponds have recently been constructed for experimental work. These ponds are designed to simulate natural estuaries but are subject to environmental control. A large series of smaller pools with flow-through control is also available.

2. The Hatteras Marine Laboratory is located at the southern end of Hatteras Island, North Carolina. Both northern and southern faunas are found in adjacent waters. There is a main office laboratory building and a large dissecting room and facilities for maintaining live organisms. Research programs include population dynamics of marine fishes.

3. The Radiobiological Laboratory at Beaufort, North Carolina, conducts studies of productivity, cycling of elements through the marine environment, and effects of radionuclides on morphology and physiology of marine organisms. Modern research laboratories with special facilities for irradiating and maintaining organisms are provided.

The University offers both the Ph.D. and M.S. in Marine Science through cooperating Departments. The requirements for the major for the Ph.D. degree are determined by the student's advisory committee. Normally, these will include four of five core courses (General, Physical, Biological, and Chemical Oceanology, and Marine Geology). Other courses will be selected from the general listing of courses in areas related to Marine Science. A doctoral candidate will be expected to take the Marine Science seminar at least twice during his period of study. A period of residence at a marine station or on an oceanographic cruise in a program approved by the supervisory committee is required. Requirements for the minor, the language, comprehensive examinations, admission to candidacy, the thesis, residence registration for dissertation and final examinations are as provided in the regulations of the Graduate School as described in the Graduate Catalogue.

The M.S. program is essentially similar to the doctoral program except that only three of the five core courses and one semester of seminar are required. Normally, a period of residence at the marine station or on an oceanographic cruise in a program approved by the student's advisory committee will be required. A thesis in a Marine Science-related area is required. Requirements for the minor, the language, admission to candidacy, residence, and final examinations are as provided in the regulations printed in the Graduate Catalogue.

The following courses in Marine Science are offered primarily in four Departments: Botany, Civil Engineering, Geosciences, and Zoology. Those courses in the primary area of marine science are designated as Oceanography courses and are organized in a non-departmental program. Opportunities for summer research are available at the coastal facilities.

CORE COURSES IN MARINE SCIENCE

| | | | |
|--------|-------------------------|----|---|
| OC 487 | Physical Oceanography | Sp | 3 |
| OC 529 | Biological Oceanography | Su | 3 |
| OC 584 | Marine Geology | Sp | 3 |
| OC 591 | Oceanology Seminar | Sp | 1 |

ADDITIONAL COURSES:

Biological Oceanology

| | | | |
|-----------|-----------------------------------|----|---|
| ZO 420 | Fishery Science I | F | 3 |
| ZO 621 | Fishery Science II | F | 3 |
| ZO 441 | Ichthyology | Sp | 3 |
| BO-ZO 442 | General Ecology | F | 4 |
| GY 486 | Weather and Climate | F | 2 |
| ZO 515 | Growth and Reproduction of Fishes | Sp | 3 |
| ZO 517 | Population Ecology | Sp | 3 |
| ZO 519 | Limnology | F | 4 |
| ZO 619 | Advanced Limnology | Sp | 3 |
| BO 574 | Phycology | Sp | 3 |
| MB 401 | General Microbiology | Sp | 4 |
| ZO 450 | Invertebrate Zoology | Sp | 4 |

Geological Oceanology

| | | | |
|---------|----------------------------------|----|---|
| GY 452 | Exogenic Materials and Processes | F | 4 |
| GY 552 | Exploratory Geophysics | Sp | 3 |
| GY 563 | Applied Sedimentology | Sp | 3 |
| GY 567 | Geochemistry | F | 3 |
| SSC 553 | Soil Mineralogy | F | 3 |

Physical Oceanology

| | | | |
|-------------|---|-------|------|
| OC 581 | Introduction to Oceanographic Engineering | F | 3 |
| OC 471 | Undersea Vehicle Design | Sp | 3 |
| CE 517 | Water Transportation | F | 3 |
| CE 548, 549 | Engineering Properties of Soils | F, Sp | 3, 3 |
| CE 641, 642 | Advanced Soil Mechanics | F, Sp | 3, 3 |
| EM 504 | Mechanics of Ideal Fluids | F | 3 |
| EM 505 | Mechanics of Viscous Fluids I | Sp | 3 |
| EM 612 | Mechanics of Viscous Fluids II | F | 3 |
| MAE 651 | Principles of Fluid Motion | F | 3 |
| MAE 431 | Thermodynamics of Fluid Flow | F, Sp | 3 |

These course offerings are supplemented by courses in Marine Science offered by the University of North Carolina at Chapel Hill. Students normally enrolled in this joint program will take courses on each campus.

The instructional staff for the courses listed above consists of the following:

Department of Biochemistry

Longmuir, Ian S., M.B.B., Professor of Biochemistry

Department of Botany

Cooper, Arthur W., Ph.D., Professor of Botany

Department of Civil Engineering

Amein, Michael, Ph.D., Associate Professor of Civil Engineering

Langfelder, L. Jay, Ph.D., Associate Professor of Civil Engineering

Department of Economics

King, Richard A., Ph.D., Professor of Economics

Department of Food Science

Webb, Neil B., Ph.D., Associate Professor of Food Science

Department of Geosciences

Leith, Carlton J., Ph.D., Professor and Head of Geosciences

Lyman, John, Ph.D., Professor of Geosciences

Smith, James R., M.S., Adjunct Assistant Professor of Oceanology

Welby, Charles W., Ph.D., Associate Professor of Geosciences

Department of Mechanical and Aerospace Engineering

Williams, James C., III, Ph.D., Professor of Mechanical and Aerospace Engineering

Department of Soil Science

Woodhouse, William W., Ph.D., Professor of Soil Science

Department of Zoology

Hassler, William W., Ph.D., Professor of Zoology

Hayne, Don W., Ph.D., Professor of Zoology and Experimental Statistics

Hobbie, John E., Ph.D., Associate Professor of Zoology

Horton, Donald B., Ph.D., Assistant Professor of Zoology

Adjunct members, located at U. S. Department of Interior Radiobiological Laboratory,
Beaufort, North Carolina:

Angelovic, Joseph W., Ph.D., Adjunct Assistant Professor of Zoology

Rice, Theodore R., Ph.D., Adjunct Professor of Zoology

Williams, Richard B., Ph.D., Adjunct Assistant Professor of Zoology

Wolfe, Douglas A., Ph.D., Adjunct Assistant Professor of Zoology

To obtain further information, address all inquiries directly to:

Dean, Graduate School

Peele Hall

North Carolina State University

Raleigh, North Carolina 27607

THE UNIVERSITY OF NORTH CAROLINA

Chapel Hill, North Carolina

The University of North Carolina at Chapel Hill (UNC-CH) and North Carolina State University at Raleigh (NCSU-R) cooperate to offer a Curriculum in Marine Sciences that involves several departments at each university. This description includes only the facilities and faculty at UNC-CH; see also the description of the NCSU-R program in this publication for full understanding of our joint program.

The University of North Carolina has teaching and research facilities on the Campus at Chapel Hill and at the Institute of Marine Sciences at Morehead City, N. C. Courses are taught on campus in several departments and research projects are also conducted in departmental laboratories. Special research facilities on campus include biological incubators; electron microscopes; gas chromatographs; infra-red spectrometers; atomic absorption spectrometer; liquid scintillation counters; gamma spectrometer; and mass spectrometer. The principle research facility, however, is the Institute of Marine Science. A new laboratory building providing 20,000 square feet of space was completed on the shore of Bogue Sound in 1968. The R/V MACHAPUNGA, a 48-foot diesel-powered vessel specially built for estuarine research, is equipped with radio-telephone, fathometer, generators for 100 v. a-c. and 32 v. d-c., and a hydraulic winch for handling gear; it has a 600 mile cruising range and living accommodations for four persons. Several outboard-powered small boats are available. Additional facilities at this coastal laboratory include a library, research collections of fishes, decapod crustaceans, and mollusks, photographic darkroom, radio-isotope facilities, a large pier, a running-saltwater system in a separate wing of the laboratory, large outdoor seawater tanks, and experimental seawater ponds. Research equipment includes microscopes, in situ salinometers, sampling bottles, nets, and trawls, pyreheliometers, submarine photometer, oxygen analyzers, histological equipment, gas chromatograph, spectrophotometers, and many other types of general laboratory equipment such as hoods, incubators, balances, centrifuges, and pH meters.

The University offers the degrees of Ph.D. and M.S. in Marine Sciences under the Curriculum in Marine Sciences. For the Ph.D. degree each student will ordinarily take at least four of the following courses, General Oceanography (101), Physical Oceanography (at NCSU-R, Duke U., or elsewhere), Geological Oceanography (103), Biological Oceanography (104s), and Chemical Oceanography (105), although his committee may approve other courses as satisfactory substitutes. He must also take Seminar in Marine Sciences (206) at least twice and will study or do research at a marine laboratory or on an oceanographic cruise in a program approved by his committee. The dissertation will be on a marine topic. A minor is optional. A reading knowledge of two foreign languages is required; in some cases a research skill such as mathematics, statistics, or information science may be substituted for one language.

For the M.S. degree each student must earn at least twenty-four (24) semester hours of credit, including at least three of the courses listed above for the Ph.D. degree, or substitute courses that are satisfactory to his committee. He must take Seminar in Marine Sciences (206) at least once, and a period of residence at a marine station or on an oceanographic cruise will ordinarily be required. A thesis on a marine topic is required. A minor is optional. A reading knowledge of one foreign language is required.

Courses in the marine sciences are offered during the academic year on the Chapel Hill campus by the Department of Botany, Department of Environmental Sciences and Engineering, Department of Geology, and Department of Zoology. Summer courses are sponsored by the Departments of Botany, Geology, and Zoology are taught at the Institute of Marine Sciences by faculty of these departments and the Institute.

Curriculum in Marine Sciences

| | | | |
|------|--|----|---|
| 101 | General Oceanography (Zoology 126) | F | 3 |
| 103 | Geological Oceanography (Geology 173) | Sp | 3 |
| 104s | Biological Oceanography (Zoology 140s) | Su | 6 |
| 105 | Chemical Oceanography (Environmental Sciences 128) | Sp | 3 |

Curriculum in Marine Sciences—Continued

| | | | |
|-----|-----------------------------|-----------|-----------|
| 206 | Seminar in Oceanography | Sp | 1 |
| 300 | Research in Marine Sciences | F, Sp, Su | 2 or more |
| 393 | Master's Thesis | F, Sp, Su | 2 or more |
| 394 | Doctoral Dissertation | F, Sp, Su | 2 or more |

Botany Department

| | | | |
|-----|-----------------|----|---|
| 215 | Marine Mycology | Su | 6 |
| 216 | Marine Algae | F | 5 |

Department of Environmental Sciences and Engineering

| | | | |
|-----|---------------------------------------|----|---|
| 231 | Environmental Microbiology | Sp | 3 |
| 232 | Limnology and Water Pollution | Sp | 3 |
| 233 | Microbial Ecology | F | 4 |
| 235 | Ecology of Phytoplankton (Botany 245) | F | 4 |

Department of Geology

| | | | |
|-----|-----------------------|----|---|
| 117 | Clay Mineralogy | Sp | 4 |
| 161 | Applied Geophysics | F | 4 |
| 162 | Applied Geophysics | Sp | 4 |
| 165 | Physics of the Earth | Sp | 3 |
| 247 | Sedimentation | F | 4 |
| 248 | Sedimentary Petrology | Sp | 4 |

Department of Zoology

| | | | |
|----------|-------------------------------------|-------|------|
| 109 | Introduction to Hydrobiology | Sp | 4 |
| 146 | Marine Ecology | Sp | 4 |
| 156, 157 | Advance Marine Invertebrate Zoology | F, Sp | 4, 4 |
| 208A | Population Ecology | Sp | 3 |
| 208B | Methods in Population Analysis | Sp | 2 |
| 213 | Advanced Marine Ecology | Sp | 3 |

The instructional staff for the courses listed above consists of the following:

Department of Botany

Hommersand, Max H., Ph.D., Associate Professor of Botany

Department of Environmental Sciences and Engineering

Johnson, J. Donald, Ph.D., Associate Professor of Environmental Chemistry

Kuenzler, Edward J., Ph.D., Associate Professor of Environmental Biology

Lyman, John, Ph.D., Professor of Oceanography

Mah, Robert A., Ph.D., Associate Professor of Environmental Microbiology

Weiss, Charles M., Ph.D., Professor of Environmental Biology

Department of Geology

Ingram, Roy L., Ph.D., Professor of Geology

St. Jean, Joseph, Jr., Ph.D., Professor of Geology

Textoris, Daniel A., Ph.D., Associate Professor of Geology

Watkins, Joel S., Ph.D., Associate Professor of Geology

Department of Zoology

Jenner, Charles E., Ph.D., Professor of Zoology

Odum, Howard T., Ph.D., Professor of Zoology and Botany and Environmental Biology

Riedl, Rupert, Dr. phil. habil., Kenan Professor of Zoology, Research Professor at the Institute of Marine Sciences

Institute of Marine Sciences

Chestnut, Alphonse F., Ph.D., Professor, and Director of the Institute of Marine Sciences

Kohlmeyer, Jan J., Dr. rer. Nat., Assistant Professor in the Institute of Marine Sciences

Schwartz, Frank J., Ph.D., Associate Professor in the Institute of Marine Sciences

Williams, Austin B., Ph.D., Professor in the Institute of Marine Sciences

Woods, William J., Ph.D., Assistant Professor in the Institute of Marine Sciences

To obtain further information, address all inquiries directly to:

Dr. Edward J. Kuenzler
Curriculum in Marine Sciences
University of North Carolina
P. O. Box 630
Chapel Hill, North Carolina 27514

UNIVERSITY OF NORTH DAKOTA
Grand Forks, North Dakota

On the main campus in Grand Forks are four laboratories for fishery biology and limnology teaching and research, a marine aquarium facility, and oceanography teaching laboratory. Related facilities on the campus include the Computer Center containing an IBM 360 system and libraries containing the major fisheries biology, limnology and oceanography journals. The Chester Fritz Library is a Depository Library for Federal Government publications. The University Biological Station at Devils Lake has facilities for limnological and fishery research and boats and equipment for small lake studies.

The University offers the following degrees through the Department of Biology:

1. **Ph.D. in Biology.** The requirements for the Ph.D. degree are 90 post-baccalaureate credits, the majority of which should be in research and dissertation; credits to include 6 in Seminar and 2 or more each in advanced courses in 4 of the following 5 fields: ecology, genetics, morphology, physiology, and systematics; attendance at a marine field station; completion of a comprehensive examination; reading knowledge of two foreign languages or more intensive preparation in one foreign language; preparation and defense of a dissertation.

2. **M.S. in Biology.** The requirements for the M.S. degree are 30 post-baccalaureate credits distributed as 20 in the major and 10 in the minor; the major to include 2 credits in Seminar, 8 credits in research and thesis, and the remaining 10 in advanced courses in at least two of the following five fields: ecology, genetics, morphology, physiology, and systematics. A reading knowledge of one foreign language may be required at the option of the student's advisory committee; preparation and defense of a thesis.

The following courses are offered by the departments indicated in conjunction with the above programs:

Department of Biology

| | | | |
|-----|-----------------------|----|-------------------|
| 375 | Invertebrate Zoology | Sp | 4 |
| 425 | Ichthyology | F | 3 |
| 433 | Limnology | F | 4 |
| 438 | Fisheries Biology | Sp | 4 |
| 517 | Aquatic Plants | Sp | Alternate Years 3 |
| 519 | Aquatic Invertebrates | Sp | Alternate Years 3 |

Department of Geology

| | | | |
|-----|------------------------------|----|---|
| 316 | Introduction to Oceanography | Sp | 3 |
|-----|------------------------------|----|---|

The instructional staff for the courses listed above consists of the following:

Department of Biology

Duerr, Frederick G., Ph.D., Associate Professor of Biology; Invertebrate Zoology and Physiology

Neel, Joe K., Ph.D., Professor of Biology, Director, Biological Station; Limnology

Owen, John B., Ph.D., Assistant Professor of Biology; Fisheries Biology

Department of Geology

Moore, Walter, Ph.D., Professor of Geology; Geophysics

To obtain further information, address all inquiries directly to:

Dr. Paul B. Kannowski, Chairman
Department of Biology
University of North Dakota
Grand Forks, North Dakota 58201

NORTHEASTERN ILLINOIS STATE COLLEGE
Chicago, Illinois

The oceanography program is an interdepartmental offering. Coastal aspects of oceanography are taught during summer "sea camps" field programs operated in Ensenada (Baja California, Mexico) through special arrangements with the Escuela Superior de Ciencias Marinas of the Universidad Autonoma de Baja California. A vessel of the Mexican Coast Guard provides shipboard experience. Similar arrangements with emphasis on geological and biological aspects of ocean study have been made with the Station de Biologie Marine of the Universite de Bordeaux at Arcachon (France). The Station has two small vessels at its disposal. Students are furthermore encouraged to attend summer sessions at oceanographic stations.

The College does not offer a program leading to undergraduate or advanced degrees in the marine sciences. The undergraduate student, interested in oceanography, may follow a program leading to a B.A. degree in the earth sciences or geography, with concentration in oceanography. The graduate student may obtain an M.A. in geography or earth sciences with concentration in oceanography.

1. **B.A. in Geography.** Nine semester hours in each of the following areas: physical geography, human geography and six hours in regional geography and six hours of geography electives. The electives and six of the nine hours of physical geography may be taken in marine sciences courses.

2. **B.A. in Geography—Secondary Education.** Six hours in each physical, topical, regional geography and twelve hours of electives. The electives and three hours of physical geography may be taken in marine sciences courses.

3. **B.A. in Geography—Elementary Education.** Three hours in each of physical, economic, cultural and Anglo-American geography, plus twelve hours of geography electives. The electives may be taken in marine sciences courses.

4. **B.A. in Earth Science—Elementary Education.** Three hours in each of the following: Earth Science, Meteorology, Economic Geology and Astronomy; twelve hours of electives of which three may be in oceanography.

5. **M.A. in Geography.** The requirements include 27 credits in geography and six for thesis. Three courses (3 credits each) are required: Cartography, Statistics for Earth Sciences and Geography; and Scope and Philosophy of the Geographical Sciences. The remaining 18 credits may be taken in marine sciences courses, and the program must be organized systematically under the guidance of the faculty adviser. The thesis should be written in an area of concentration. A final examination is administered by the faculty of the Geography Department.

6. **M.A. in the Teaching of Geography.** Course requirements are 18 credits in geography—nine in education and six for thesis. The thesis requirements are the same as those for the M.A. in Geography. The only required geography course is Scope and Philosophy of the Geographical Sciences (3 credits). The three education courses totaling nine credits are Principles of Curriculum Development; Television and Related Instructional Media; and Research in the Classroom Teaching of Geography. The remaining 15 credits may all be taken in marine sciences courses.

Students may substitute for a thesis two major research papers to be written under the guidance of two geography faculty members. However, in such cases, six additional credits must be taken in geography courses (marine sciences courses qualify also), and the degree will be considered as terminal rather than leading to further studies.

The following courses are offered in conjunction with the above programs:

| | | |
|--------|---|--------|
| 43-318 | Conservation of Natural Resources | 3 |
| 43-322 | Paleogeography | 3 |
| 43-343 | Polar Geography | 3 |
| 43-351 | Statistics for Earth Sciences and Geography | 3 |
| 43-352 | Guided Study in Geography-Oceanography | 1 to 3 |
| 43-373 | Biological Geography | 3 |
| 43-374 | Cartography | 3 |
| 43-391 | Quantitative Measurements | 3 |
| 43-421 | Climatology | 3 |

| | | |
|----------------------|---|---|
| 43-431 | Thesis Seminar | 3 |
| 43-441 | Mathematical Geography | 3 |
| 53-272 | Fundamentals of Meteorology and Climatology | 3 |
| 53-313 | Stratigraphy and Sedimentology | 5 |
| 53-318 | World Regional Geology | 3 |
| 53-321 } 43-321 } | Oceanography | 3 |
| 53-324 | History of the Geological Sciences | 1 |
| 53-325 | Seminars in Earth Science | 3 |
| 53-326 | Individual Study in Earth Science | 3 |
| 56-317 | Ecology | 3 |

The instructional staff for the courses listed above consists of the following:

Department of Geography

Charlier, Roger H., Ph.D., Sc.D., Vice-Chairman and Professor of Geology, Geography and Oceanography

Dierickx, C. Wallace, Ph.D., Chairman and Professor of Geography

Odell, Clarence B., Ph.D., Visiting Professor of Cartography

Schwartz, Carroll, Ph.D., Associate Professor of Geography

Kiang, Ying-Cheng, Ph.D., Associate Professor of Geography

Bernhagen, David, M.A., Instructor in Geography

Easton, Robert, M.A., Instructor in Geography

Mulmat, Kenneth, M.A., Instructor in Geography

Department of Physical Sciences

Forslev, Albert, Ph.D., Professor of Earth Sciences

Department of Biology

Betz, Robert F., Ph.D., Professor of Biology

Wiercinski, Floyd J., Ph.D., Professor of Biology

To obtain further information, address all inquiries directly to:

Dr. Roger H. Charlier, Director
Oceanography Programs; Room C630
Northeastern Illinois State College
5500 North St. Louis Avenue
Chicago, Illinois 60625

NORTHEASTERN UNIVERSITY
Boston, Massachusetts

Northeastern University is developing a marine research institute on a 20-acre site on the shore-line at Nahant, Massachusetts. The marine facility is being utilized by faculty and graduate students for research in areas of biological oceanography, earth science and ocean engineering.

No degrees are offered in oceanography at present, but education undergraduates can major in earth science and all students may receive oceanographic background on cooperative jobs at marine-oriented corporations and firms. Advanced degrees incorporating marine research thesis problems are developed in biology, chemistry, and engineering.

The following courses in Marine Science are offered:

UNDERGRADUATE COURSES

Department of Natural Science

16.131 Oceanography I

16.132 Oceanography II

NOTE: In both courses, field trips are taken to the Woods Hole Oceanographic Institution, Boston Fish Pier, and available research vessels.

GRADUATE COURSES

Biology Department

18.830 Marine Algae

18.905 Marine Microbiology

University College Courses (Degree-oriented, part-time adult education programs)

16.531 Oceanography I

16.532 Oceanography II

16.533 Marine Geology

16.534 Fisheries Oceanography I—Survey of Commercially Important Marine Organisms

16.535 Fisheries Oceanography II—Commercial Fishing Methods, Techniques and Equipment

16.536 Fisheries Oceanography III—Commercial Fishery Products and Their Exploitation

The instructional staff for the courses listed above consists of the following:

Northeastern University Marine Institute

Riser, Nathan W., Ph.D., Director

Department of Earth Sciences

Overcash, J. Rosson, A.M.T., Chairman

Gordon, Bernard L., M.Sc., Assistant Professor

To obtain further information, address all inquiries directly to:

Professor Bernard L. Gordon
Department of Earth Science
Northeastern University
Boston, Massachusetts 02115

**NOVA UNIVERSITY
OCEANOGRAPHIC LABORATORY
Fort Lauderdale, Florida**

The Oceanographic Laboratory is part of the Physical Science Center of the University. It is housed in a waterfront facility in the Port Everglades area. Classroom and laboratory facilities are available for programs in physical, chemical and biological oceanography. The laboratory operates two small research vessels.

The University offers the Ph.D. degree in Physical Oceanography, Chemical Oceanography, Marine Biology or Physics with a dissertation in Oceanography.

Numbered courses with a specified number of credits are not given. The program for each student is adjusted to his needs and background. Pregraduate and survey courses are not given. Instruction is offered in all phases of physical and chemical oceanography and related parts of marine biology. Students are expected, upon completion of their studies, to be conversant with the latest developments in these fields. Dissertation research normally involves work at sea.

The instructional staff for the courses listed above consists of the following:

Richardson, William S., Professor of Oceanography

Carritt, Dayton E., Professor of Oceanography

Yentsch, Charles S., Associate Professor of Marine Biology

Herndon, Roy C., Associate Professor of Physics

Niiler, Pearn P., Assistant Professor of Theoretical Oceanography

Snyder, Russell L., Assistant Professor of Oceanography

Moore, Dennis W., Professor of Theoretical Oceanography

Baig, Stephen, Post Doctoral Fellow in Marine Biochemistry

Moed, Jan, Post Doctoral Fellow in Marine Biochemistry

To obtain further information, address all inquiries directly to:

Dr. William S. Richardson

Oceanographic Laboratory

1901 S.E. 15th Street

Fort Lauderdale, Florida 33316

OLD DOMINION COLLEGE
(To Become OLD DOMINION UNIVERSITY, September 1, 1969)
Norfolk, Virginia

The Institute of Oceanography offers marine science courses at both the main campus of the College in Norfolk and its Oceanographic Research Field Station at Little Creek, Virginia Beach, ten miles from the main campus. Laboratory facilities are available at both locations. Instruction given is wholly on the graduate level. A new oceanography building is scheduled for completion in 1970.

The field laboratory has deep-water docking facilities at Little Creek. These facilities serve as the base for operation of the College's research vessels, the ocean going 64-foot ALBATROSS and the 45-foot ACADIAN REBEL for estuarine and riverine survey work. Although the Institute of Oceanography is primarily involved in graduate education and scientific investigations, summer workshops are held for High School Teachers of Science and Mathematics, and research participation for undergraduate science majors is possible.

The College offers the degree of **Master of Science in Oceanography**. A minimum of twenty-eight semester hours (exclusive of research and thesis) of graduate study will be required for the Master of Science degree with a concentration in Oceanography; from three to six hours of credit will be given for the required research and thesis. Except under special circumstances, only German, Russian, French, or Spanish will be permitted to satisfy the language requirement enunciated by the Graduate Council.

The final examination for the master's degree will be an oral or written examination on the student's thesis and closely related topics given by the student's thesis committee. A student must pass this examination before he may receive his degree. Each graduate student is expected to have ten days of shipboard experience annually.

The following courses are offered in conjunction with the Master's program. Two-semester courses in the marine sciences are offered by the Institute of Oceanography during the academic year at the main campus. Undergraduate level marine science courses are presently offered by the Departments of Chemistry and Biology under the auspices of the Institute of Oceanography.

GRADUATE COURSES:

| | | |
|----------|---|-----|
| 501* | Oceanographic Instrumentation and Techniques | 3 |
| 502-503* | Advanced General Oceanography | 3 |
| 504 | Advanced Physical Oceanography | 3 |
| 505 | Dynamic Oceanography | 3 |
| 506 | Ocean Boundary Layer Interactions | 3 |
| 507-508 | Special Topics in Oceanography | 3 |
| 509 | Advanced Meteorology | 3 |
| 510 | Theoretical Chemical Oceanography | 3 |
| 512 | Advanced Chemical Oceanography | 3 |
| 522 | Stratigraphy of Coastal Plains | 3 |
| 523 | Minerals and Mineral Assemblages of Sediments | 3 |
| 531 | Marine Geophysics | 3 |
| 532 | Geochemistry of the Ocean | 3 |
| 541 | Marine Phycology | 3 |
| 542 | Marine Mycology and Microbiology | 3 |
| 543 | Physiology of Marine Plants | 3 |
| 544 | Physiology of Selected Marine Animals | 3 |
| 554* | Statistics | 3 |
| 591-592* | Seminar | 1 |
| 598* | Research | 3-6 |
| 599* | Thesis | 3-6 |

*Indicates required courses for all candidates for the M.S. degree.

UNDERGRADUATE COURSES

| | | |
|-----|-------------------------------|---|
| 415 | General Chemical Oceanography | 3 |
| 418 | Marine and Estuarine Plankton | 3 |

The instructional staff for the courses listed above consists of the following:

Full Time

Johnson, Ronald E., Ph.D., Assistant Professor of Oceanography
Ludwick, John C., Ph.D., Professor of Oceanography
Swift, Donald J. P., Ph.D., Associate Professor of Oceanography
Zaneveld, Jacques S., Ph.D., Professor of Oceanography

Part Time

Gosink, Thomas A., Ph.D., Assistant Professor of Chemistry
Marshall, Harold G., Ph.D., Professor of Biology

To obtain further information, address all inquiries directly to:

Dr. Jacques S. Zaneveld, Director
Old Dominion College
Institute of Oceanography
Norfolk, Virginia 23508

OREGON STATE UNIVERSITY Corvallis, Oregon

The Department of Oceanography is housed in a four-story Oceanography Building on the Corvallis campus. This building contains 30,000 square feet of office and laboratory space. The laboratories are well equipped for research in each of the aspects of oceanography stressed in our current program.

The newly constructed Marine Science Center is located at Newport on the shores of Yaquina Bay, 56 miles west of Corvallis. One of the three wings of the laboratory building houses research in coastal aspects of oceanography and marine biology. The Center also provides shore support and docking facilities for the Department's research vessels and a new marina for small boats.

Two research vessels, the YAQUINA and CAYUSE, comprise the Oregon State University marine science fleet. The 180-foot YAQUINA is capable of carrying out extended cruises anywhere in the oceans of the world. The vessel carries a crew of 17-21, and can accommodate 19 scientists. She houses eight research laboratories and is outfitted with three oceanographic winches and related gear for effective sampling of all kinds. With a cruising range of 6,500 miles, she can remain at sea for more than 30 days.

The 80-foot CAYUSE is equipped for all types of marine research, and is designed for research in the area of the continental shelf and slope off the Pacific Northwest coast. There are quarters for seven crew members and seven scientists, plus a wet laboratory for hydrographic work, a dry laboratory, and an electronic laboratory. Graduate students in oceanography receive much of their training on the CAYUSE.

The University offers the following graduate degrees in the marine sciences:

1. Master of Arts in Oceanography
2. Master of Science in Oceanography
3. Master of Science in Oceanography (Geophysics)
4. Master of Science in General Science (no thesis required)
5. Doctor of Philosophy in Oceanography
6. Doctor of Philosophy in Oceanography (Geophysics)

Students may specialize in any of the following fields: physical, chemical, biological, radioecological, geological, or geophysical oceanography; geophysics.

The University offers numerous courses in the Marine Sciences. Some courses are offered by the Department of Oceanography in the summer primarily for science teachers. These courses carry graduate credit and can be applied to a minor in oceanography.

The Marine Science Center in Newport offers courses which are biological in nature with emphasis on field study. In some cases credit received for these courses can be applied to an oceanography major.

UNDERGRADUATE COURSES:

| | | | |
|--------|------------------------------|----------|---|
| Oc 133 | Elements of Oceanography | F, W, Sp | 3 |
| Oc 331 | Introduction to Oceanography | F, W, Sp | 3 |

UPPER DIVISION COURSES CARRYING GRADUATE CREDIT (Courses designated (G)

can be applied to a graduate major; courses designated (g) can be applied to a graduate minor only):

| | | | |
|--------|---------------------------------------|----|-----|
| Mb 415 | Marine Microbiology (g) | Sp | 2 |
| Mb 416 | Marine Microbiology Laboratory (g) | Sp | 2 |
| GS 431 | Physical Limnology (G) | W | 3 |
| GS 501 | Field Research in Physical Limnology | Sp | 1-3 |
| Oc 431 | Physical Oceanography (G) | F | 4 |
| Oc 432 | General Physical Oceanography (G) | F | 3 |
| Oc 433 | Currents and Water Masses (G) | W | 3 |
| Oc 434 | Estuarine and Shoreline Processes (G) | Sp | 3 |
| Oc 438 | Light and Sound in the Sea (G) | F | 3 |
| Oc 441 | Biological Oceanography (G) | F | 4 |

UPPER DIVISION COURSES CARRYING GRADUATE CREDIT—Continued

| | | | |
|--------|-----------------------------|----|---|
| Oc 442 | Marine Zooplankton (G) | W | 5 |
| Oc 451 | Chemical Oceanography (G) | W | 4 |
| GS 461 | Marine Radioecology (G) | W | 3 |
| Oc 461 | Geological Oceanography (G) | Sp | 4 |
| Oc 480 | Marine Geophysics (G) | F | 3 |

GRADUATE COURSES:

| | | | |
|--------|------------------------------------|-------------------------------|--|
| Oc 501 | Research | Term and hours to be arranged | |
| Oc 501 | Research in Gamma Ray Spectrometry | Term and hours to be arranged | |
| Oc 503 | Thesis | Term and hours to be arranged | |
| Oc 505 | Reading and Conference | Term and hours to be arranged | |
| Oc 507 | Seminar | Term and hours to be arranged | |
| Oc 507 | Seminars: | | |

| | | | |
|--------|--|----------|-----------|
| | Readings in Biological Oceanography | F, W, Sp | 1, 1, 1 |
| | Readings in Chemical Oceanography | F, W, Sp | 1, 1, 1 |
| | Readings in Geophysics | F, W, Sp | 1, 1, 1 |
| | Physics of the Earth | W | 3 |
| | Gamma Ray Spectrometry | W | No Credit |
| | Marine Radioecology | F, W, Sp | 1, 1, 1 |
| G 540 | Micropaleontology | F | 4 |
| Oc 542 | Marine Nekton | Sp | 3 |
| Oc 543 | Marine Nekton Laboratory | Sp | 1 |
| Oc 544 | Marine Phytoplankton Ecology | F | 3 |
| Oc 545 | Marine Phytoplankton Physiology | W | 3 |
| Oc 546 | Marine Primary Production | Sp | 5 |
| Oc 547 | Marine Phytoplankton Systematics | W | 3 |
| Oc 548 | Marine Benthic Ecology | F | 4 |
| Oc 552 | Chemical Oceanography | W | 4 |
| Oc 553 | Descriptive Chemical Oceanography | F | 4 |
| Oc 554 | Theoretical Chemical Oceanography | F | 4 |
| Oc 565 | Geology of the Ocean Basins | W | 3 |
| Oc 566 | Marine Sedimentation | Sp | 3 |
| Oc 568 | Ecology of Foraminifera | W | 3 |
| Oc 569 | Distribution of Modern Foraminifera | W | 2 |
| Oc 570 | Theoretical Physical Oceanography | W | 4 |
| Oc 571 | Marine Hydrodynamics | F | 4 |
| Oc 573 | Waves and Tides | Sp | 4 |
| Oc 575 | Oceanographic Analysis* | F | 1—3 |
| Oc 576 | Turbulence I* (alternate years) | W | 3 |
| | Turbulence II* (alternate years) | W | 3 |
| | Stratified Fluids* | W | 3 |
| Oc 577 | Boundary Oceanography* | Sp | 2 |
| Oc 580 | Theoretical Geophysics, Sound Transmission | W | 2 |
| Oc 581 | Theoretical Geophysics, Earth Gravity | F | 3 |
| Oc 582 | Theoretical Seismology | F | 3 |
| Oc 583 | Earthquake Seismology | Sp | 3 |
| Oc 584 | Physics of the Earth | W | 3 |

The following Oceanography Courses for Teachers are offered:†

| | | | |
|---------|--------------------------------------|--------|---|
| Oc 590 | Biological Oceanography for Teachers | Sp, Su | 3 |
| Oc 591 | Physical Oceanography for Teachers | F, Su | 3 |
| Oc 592x | Geological Oceanography for Teachers | Su | 3 |
| Oc 593x | Chemical Oceanography for Teachers | Su | 3 |

*Special Topics in Physical Oceanography

†Credit will not count toward a graduate major in Oceanography

The instructional staff for the courses listed above consists of the following:

Byrne, John V., Ph.D., Department Chairman, Professor, Geological Oceanography
Beardsley, George F., Ph.D., Assistant Professor, Physical Oceanography
Bodvarsson, Gunnar, Ph.D., Professor, Geophysics and Mathematics
Burt, Wayne V., Ph.D., Sc.D., Associate Dean of Research; Professor, Physical Oceanography
Caldwell, Douglas, Ph.D., Assistant Professor, Physical Oceanography
Carey, Andrew G., Jr., Ph.D., Assistant Professor, Biological Oceanography
Couch, Richard, M.S., Instructor, Geophysics
Curl, Herbert C., Jr., Ph.D., Associate Professor, Biological Oceanography
Forster, William O., Ph.D., Assistant Professor, Radioecology
Fowler, Gerald A., Ph.D., Assistant Professor, Geological Oceanography
Frolander, Herbert F., Ph.D., Professor, Biological Oceanography
Gonor, Jefferson J., Ph.D., Assistant Professor, Biological Oceanography
Hedgpeth, Joel W., Ph.D., Professor, Biological Oceanography
Heinrichs, Donald F., Ph.D., Assistant Professor, Geophysics
Kulm, Laverne D., Ph.D., Assistant Professor, Geological Oceanography
Longuet-Higgins, Michael S., Ph.D., Professor, Physical Oceanography
McCauley, James E., Ph.D., Associate Professor, Biological Oceanography
Mesecar, Roderick S., Ph.D., Assistant Professor, Physical Oceanography
Neal, Victor T., Ph.D., Assistant Professor, Physical Oceanography
Neshyba, Stephen J., Ph.D., Associate Professor, Physical Oceanography
Park, P. Kilho, Ph.D., Associate Professor, Chemical Oceanography
Patiullo, June G., Ph.D., Professor, Physical Oceanography
Percy, William G., Ph.D., Associate Professor, Biological Oceanography
Pond, G. Stephen, Ph.D., Assistant Professor, Physical Oceanography
Pytkowicz, Ricardo M., Ph.D., Associate Professor, Chemical Oceanography
Renfro, William, Ph.D., Assistant Professor, Radioecology
Small, Lawrence F., Ph.D., Associate Professor, Biological Oceanography
Smith, Robert L., Ph.D., Assistant Professor, Physical Oceanography
Van Andel, Tjeerd H., Ph.D., Professor, Geological Oceanography
Wyatt, Bruce, M.S., Instructor, Physical Oceanography

To obtain further information, address all inquiries directly to:

Dr. John V. Byrne, Chairman
Department of Oceanography
Oregon State University
Corvallis, Oregon 97331

UNIVERSITY OF OREGON
OREGON INSTITUTE OF MARINE BIOLOGY
Eugene, Oregon

The University offers marine biology courses at both its main campus in Eugene and at Oregon Institute of Marine Biology, Charleston, Oregon. A new science building at Eugene includes modern laboratory facilities for biology, chemistry, molecular biology and physics departments.

Oregon Institute of Marine Biology has been in operation for about 30 years and is located on about 85 acres along Coos Bay at Charleston, Oregon. The Institute buildings provide dormitories, dining hall, classrooms, and laboratories. There are six laboratory classrooms, with running salt water, study tables and benches, and lamps. By summer of 1969 five new laboratories are to be completed.

No degrees are offered by the Institute; however, the University of Oregon awards credit, including graduate credit for all courses designated (G), or at the 500 level, for all courses taken at the Institute. Work done at the Institute may form an integral part of the work towards Bachelor's, Master's, or Doctor's degrees in Biology offered on the Eugene campus.

Courses in the marine sciences are offered during the regular year at the main campus by the Department of Biology and Graduate School. The Department of Biology and the Graduate School also offer both regular summer and special workshop courses at the Institute of Marine Biology, Charleston. Independent studies and research have been carried out on a year-round basis at the Institute since 1968.

The following courses will be offered at the Institute during the Summer 1969 session:

| | | |
|-------------|--|---|
| Bi 461, 462 | Invertebrate Zoology (G) | 8 |
| Bi 482 | Experimental Invertebrate Embryology (G) | 4 |
| Bi 491 | Comparative Physiology (G) | 4 |
| Bi 401, 501 | Research | |
| Bi 403, 503 | Thesis | |
| Bi 407, 507 | Seminar | |
| Bi 408 | Laboratory Projects | |

The instructional staff for the courses listed above consists of the following:

Department of Biology

Rudy, Paul P., Ph.D., Acting Director, Oregon Institute of Marine Biology, and Assistant Professor of Biology

Cather, James N., Ph.D., Associate Professor of Biology (Visiting—1969)

McConnaughey, Bayard H., Ph.D., Associate Professor of Biology

Moberly, Walter, Ph.D., Assistant Professor of Biology

Oglesby, Larry C., Ph.D., Assistant Professor of Biology (Visiting—1969)

To obtain further information, address all inquiries directly to:

Dr. Paul P. Rudy, Acting Director
Oregon Institute of Marine Biology
Charleston, Oregon 97420

**UNIVERSITY OF THE PACIFIC
Stockton, California**

and the

**PACIFIC MARINE STATION
Dillon Beach, California**

The Pacific Marine Station provides opportunities for study and research in marine biology and related fields of science. The facilities include laboratories, a library, a research museum, darkrooms, and living accommodations. A 34-foot, twin diesel, steel research vessel, BLACK SWAN; a 16-foot Boston Whaler; a 26-foot whaleboat, and various smaller boats are available.

The University offers the degree of Master of Science. A minimum of 30 units must be completed for the degree, of which at least 16 must be selected from graduate course offerings in the Department of Biological Sciences (including four units of thesis). The remaining 14 units of course work may be selected from other offerings within the university with approval of the student's graduate committee. Candidates must pass an oral examination in Biology and demonstrate a reading knowledge of at least one of the following: French, German, Russian, or Spanish. An acceptable thesis in the area of the student's major interest is required. For further details consult the Graduate School Bulletin, University of the Pacific.

The following courses are offered by the University in conjunction with the above program. During the academic year there are opportunities for advanced study in problems of marine ecology and invertebrate zoology.

Undergraduate and graduate courses are offered during the summer sessions on a non-matriculation basis. These courses are accepted by many university departments in fulfillment of advanced degree requirements for study at a marine station. Usually three formal courses are offered during the 10 week summer session, all of which are given by visiting instructors from other institutions.

Students from other colleges who desire to study at Pacific Marine Station should plan to begin their program by attending classes at the Station during the summer session before taking up academic year residence at Dillon Beach; formal admission procedures may be deferred until the fall semester.

GRADUATE COURSES (REGULAR SESSION) (PACIFIC MARINE STATION):

| | |
|-----|--|
| 213 | Advanced Invertebrate Zoology |
| 219 | Comparative Histology and Microtechnique |
| 294 | Directed Studies |
| 235 | Introduction to Oceanography |
| 245 | Ecological Physiology |
| 296 | Graduate Seminar |

**GRADUATE AND UNDERGRADUATE COURSES (SUMMER SESSION)
(PACIFIC MARINE STATION)**

| | |
|------|--------------------------|
| S112 | Invertebrate Zoology |
| S124 | Marine Botany (Algology) |
| S137 | Marine Paleontology |
| S127 | Ichthyology |

The instructional staff for the courses listed above consists of the following:

Smith, Edmund H., Ph.D., Director, Pacific Marine Station; Associate Professor of Zoology, University of the Pacific

Tucker, John S., Ph.D., Research Associate Professor, Pacific Marine Station; Associate Professor of Natural Science, Raymond College

Marcus, Stanley J., E.M., Associate to the Director, Assistant Professor of Oceanography

Johnson, Ralph G., Ph.D., Adjunct Professor of Paleontology, University of the Pacific (Pacific Marine Station), Associate Professor of Paleontology, University of Chicago

Loosanoff, Victor L., Ph.D., Adjunct Professor of Marine Biology, University of the Pacific (Pacific Marine Station)

Brice, Arthur T., M.A., Adjunct Professor of Microbiology, Phase Contrast, University of the Pacific (Pacific Marine Station)

Underhill, Raymond A., Ph.D., Research Associate (Polychaete development and ecology)

To obtain further information, address all inquiries directly to:

Edmund H. Smith, Director

Pacific Marine Station

Dillon Beach, Marin County, California 94929

UNIVERSITY OF PUERTO RICO
Mayaguez, Puerto Rico

The Department of Marine Sciences was established as the Institute of Marine Biology on the Mayaguez campus of the University of Puerto Rico in 1954. The main offices are located on campus, at present in the former fisheries building but within two years to be moved to a new building being built for marine sciences, geology and physics. The department's marine station is 22 miles to the south on 18-acre Magueyes Island which is about 100 yards offshore from La Parguera. The island is within a broad embayment which is notable for many types of marine habitats. Buildings at the station include a staff laboratory building, an aquarium building with a large classroom and several service buildings. In addition to skiffs, the department operates the 58-foot MEDUSA fitted with basic equipment for oceanographic and marine biological work.

The University offers the degree of M.S. in Marine Sciences. All candidates are required to complete a minimum of 30 credit hours of graduate credit. Of these only 6 credits may be in courses open to advanced undergraduate as well as graduate students, and a minimum of 6 credits must be in related courses offered in the graduate programs of other departments. All of the candidates must demonstrate facility in Spanish and English as well as ability to read and translate in one other modern language in which there is sufficient scientific literature in their field of specialization. They must satisfactorily complete a research project, a thesis based on the project, and a comprehensive oral examination.

The following courses are offered in conjunction with the M.S. program:

ADVANCED UNDERGRADUATE AND GRADUATE COURSES

| | | | |
|-----|-------------------------------------|----|---|
| 553 | Fisheries Biology | | 3 |
| 558 | Systematics of Marine Invertebrates | Su | 3 |
| 564 | Ichthyology I | | 3 |
| 595 | Marine Ecology | Su | 6 |

GRADUATE COURSES

| | | | |
|---------|---|--|---------|
| 601 | Coastal Geomorphology | | 3 |
| 605 | Geology of Deep Ocean Basins | | 3 |
| 611 | Coastal Processes | | 3 |
| 618 | Oceanographic Hydrodynamics | | 3 |
| 619 | Special Problems in Physical Oceanography | | 1-3 |
| 621-622 | Marine Sciences | | 4 |
| 625 | Marine Microbiology | | 3 |
| 631 | Marine Physiology | | 3 |
| 632 | Marine Physiology Laboratory | | 1 or 2 |
| 635 | Marine Biogeography | | 3 |
| 638 | Selected Topics in Physiological Ecology | | 3 |
| 640 | Special Problems in Marine Physiology | | 3 |
| 646 | Morphology of Marine Invertebrates | | 3 |
| 647 | Special Problems in Marine Invertebrates | | 1-3 |
| 648 | Marine Invertebrate Embryology | | 3 |
| 652 | Biological Oceanography | | 3 |
| 653 | Special Problems in Fisheries Biology | | 1-3 |
| 661 | Marine Botany | | 3 |
| 662 | Special Problems in Marine Algae | | 1-3 |
| 665 | Ichthyology II | | 3 |
| 666 | Special Problems in Ichthyology | | 1-3 |
| 668 | Pigment Physiology | | 3 |
| 671 | Instrumental Methods in Marine Sciences | | 3 |
| 681 | Ecology of Marine Communities | | 2 |
| 691-692 | Graduate Seminar | | 1 |
| 695 | Special Problems | | 1-3 |
| 699 | Research | | Up to 6 |

The instructional staff for the courses listed above consists of the following:

Department of Marine Sciences

Cerame-Vivas, Maximo J., Ph.D., Director and Associate Professor

Almodóvar, Luis R., Ph.D., Professor

Burkholder, Paul H., Ph.D., Professor

Cutress, Charles E., M.S., Associate Professor

Eger, William H., M.S., Assistant Professor

Giese, Graham S., Ph.D., Assistant Professor

Glynn, Peter W., Ph.D., Associate Professor

González, Juan G., M.S., Assistant Professor

Maddux, William S., Ph.D., Assistant Professor

Ting, Robert Y., Ph.D., Associate Professor

Tosteson, Thomas R., Ph.D., Associate Professor

Zeigler, John M., Ph.D., Professor

To obtain further information, address all inquiries directly to:

Dr. Máximo J. Cerame-Vivas, Director

Department of Marine Sciences

University of Puerto Rico

Mayaguez, Puerto Rico 00708

UNIVERSITY OF RHODE ISLAND
Kingston, Rhode Island

The Graduate School of Oceanography, maintains a group of laboratories, offices and support facilities at the Narragansett Bay Campus, a waterfront location in Narragansett, R. I. Principal structures are the Charles J. Fish Oceanographic Laboratory, a new 30,000 square foot laboratory and the Claiborne Pell Marine Science Library, the latter two completed in 1968. The graduate school operates R/V TRIDENT, a 180-foot research vessel, and a number of small craft.

The University offers the degrees of Master of Science in Oceanography and Doctor of Philosophy in Oceanography. Both degrees are given with options in biological, chemical, geological, and physical oceanography.

The following courses in the marine sciences are offered in conjunction with these programs. In addition, graduate students in oceanography may choose from supporting courses in other departments of the University.

| | |
|----------|--|
| 100 | General Oceanography |
| 201 | Physical Oceanography |
| 210 | Descriptive Physical Oceanography |
| 211 | Geophysical Hydrodynamics |
| 213 | Waves |
| 221 | Chemical Oceanography |
| 225 | Organic Geochemistry |
| 230 | Geochemistry |
| 231 | Seminar in Marine Geochemistry |
| 240 | Geological Oceanography |
| 243 | Seminar in Deep-Sea Geology |
| 244 | Thermodynamics of the Earth's Interior |
| 245 | Geology of Continental Margins |
| 247 | Recent Sedimentary Environments |
| 261 | Biological Oceanography |
| 264 | Phytoplankton |
| 266 | Zooplankton |
| 267 | Marine Bacteriology |
| 268 | Fishery Biology |
| 271 | The Benthic Environment |
| 272 | Marine Invertebrates and Environment |
| 273 | Advanced Animal Behavior |
| 274 | Biology of Marine Mammals |
| 291, 292 | Individual Study |
| 293, 294 | Special Studies |
| 361 | Ecological Concepts in Marine Research |
| 391 | Seminar in Oceanography |

The University also offers a graduate program in ocean engineering and an associate program in fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Knauss, John A., Ph.D., Dean, Professor and Provost for Marine Affairs
Marshall, Nelson, Ph.D., Professor
Pratt, David M., Ph.D., Professor
Saila, Saul B., Ph.D., Professor
Sieburth, John McN., Ph.D., Professor
Stern, Melvin E., Ph.D., Professor
Winn, Howard E., Ph.D., Professor
Jeffries, Perry H., Associate Professor
Krause, Dale C., Associate Professor

McMaster, Robert L., Ph.D., Associate Professor
Smayda, Theodore J., Dr., Philos., Associate Professor
Diamantis, Basil, Ph.D., Assistant Professor
Kenyon, Kern, Ph.D., Assistant Professor
Lambert, Richard B., Ph.D., Assistant Professor
Napora, Theodore A., Ph.D., Assistant Professor and Assistant Dean for Students
Pilson, Michael E., Ph.D., Assistant Professor
Quinn, James G., Ph.D., Assistant Professor
Sastry, Akella N., Ph.D., Assistant Professor
Schilling, Jean-Guy, Ph.D., Assistant Professor
Sturges, Wilton III, Ph.D., Assistant Professor
Swift, Elijah, Ph.D., Assistant Professor
LaRoche, Gilles, Ph.D., Adjunct Professor
Shuster, Carl N., Ph.D., Adjunct Professor

To obtain further information, address all inquiries directly to:

Dr. John A. Knauss, Dean, Professor and Provost for Marine Affairs

Dr. Theodore A. Napora, Assistant Professor and Assistant Dean for Students

University of Rhode Island
Kingston, Rhode Island 02881

RUTGERS UNIVERSITY
New Brunswick, New Jersey

The University does not offer programs in oceanography or marine sciences as such but does offer marine oriented courses in biology, engineering, and geology at the three campuses, New Brunswick, Newark and Camden. The classroom facilities are typical for the three sciences mentioned. There are three off-campus facilities for biology research at the graduate level: a converted Coast Guard station for the study of purifying hard shell clams at Monmouth Beach; a laboratory and compound for studying oyster production near Cape May on the Delaware Bay; and a small houseboat for studying estuarine ecology in Mullica Bay.

The following degrees are offered:

1. B.S.--general preparation for research and graduate studies in marine science.
2. M.S. in Aquatic Biology (salt and fresh water), Aquatic Weed Control, Environmental Radioactivity, Marine and Estuarine Ecology, Marine Microbiology, Marine Nematology, Meteorology (general), Soil and Water Chemistry, Stream and Estuary Sanitation, Water Pollution, Water Resources, Water-based Recreation.
3. Ph.D. in Aquatic Biology (salt and fresh water), Aquatic Weed Control, Environmental Radioactivity, Marine and Estuarine Ecology, Marine Microbiology, Marine Nematology, Soil and Water Chemistry, Stream and Estuary Sanitation, Water Pollution, Water Resources, Water-based Recreation.

The following courses are offered in conjunction with the above programs:

Field of Biology

| | |
|---------|--------------------------------|
| 375:403 | Air and Water Environment |
| 375:404 | Aquatic Biology |
| 375:444 | Water Resources |
| 375:505 | Stream Sanitation |
| 375:510 | Microbiology of Water |
| 375:511 | Ichthyology |
| 375:512 | Fishery Management |
| 990:406 | Limnology |
| 990:504 | Elements of Oceanography |
| 990:506 | Ecology of the Estuary |
| 120:415 | Marine Ecology |
| 130:411 | Algae: Morphology and Taxonomy |
| 130:513 | Algae: Biology and Physiology |

Department of Geology

| | |
|---------|--------------|
| 450:401 | Ocean Basins |
|---------|--------------|

The instructional staff for the courses listed above consists of the following:

College of Agriculture

Faust, J. D., Dr. (Environmental Science)
Havens, A. V., Professor (Meteorology)
Primer, D., Dr. (Microbiology)
Westman, J. R., Dr. (Environmental Science)

Department of Botany

Moul, E. T., Dr.

Department of Geology

Fox, S. K., Dr.
Johnson, H., Dr.
Murray, R. C., Dr.
Olsson, R. K., Dr.

Department of Zoology

Haskin, H., Dr.

Loveland, R., Dr.

McDowell, S. B., Dr.

Stauber, L., Dr.

To obtain further information, address all inquiries directly to:

Chairman of the All-University Committee on Oceanography

Dr. Walter A. Maclinn, Director

New Jersey Agricultural Experiment Station

Rutgers University—The State University of New Jersey

New Brunswick, New Jersey 08903

SACRAMENTO STATE COLLEGE

Sacramento, California

The college offers marine science courses on the Sacramento campus in the Departments of Biological Sciences and Physics—Physical Sciences (as part of the curricula in environmental biology and geology, respectively). The college also participates in the operation of the Moss Landing Marine Laboratories in Moss Landing, California (on Monterey Bay), as part of a consortium of five California State Colleges described in the Consortia section. The science departments at the college occupy a five-story science building completed in 1967; the Biological Sciences Department occupies approximately one-and-one-half floors of space in this large building, as well as retaining the two-story building occupied earlier; these aggregate about 69,000 sq. ft. of floor space, 45,000 in the larger building and 24,000 in the smaller. The Physics-Physical Sciences Department takes up approximately one-and-a-half stories of space. Laboratories are modern and functional. The Biological Sciences Department maintains a 23-foot research inboard power cruiser and several smaller boats and the science building has salt water facilities. The Sacramento campus is located within an hour's drive of estuarine environments and within two hour's drive of the Pacific Ocean.

The following degrees are offered:

1. **B.A. in Biological Sciences.** A broad based, normal 124 semester-unit baccalaureate degree. Chemistry, physics, mathematics and statistics required as supporting subjects. For the marine sciences specialty—Bio. Sci. 150, 162, 163 and Geology 101 are specified and Bio. Sci. 173 is recommended.

2. **B.S. in Biological Sciences (Biological Conservation (Fish and Game)).** This is a 132 semester-unit degree, which consists of the basic biology curriculum, with the addition of certain fish and game and other conservation courses.

3. **M.A. in Biological Sciences.** Students take several required courses in biological sciences, as well as supporting courses. A thesis is required. Certain courses and the thesis research can be done at Moss Landing Marine Laboratories.

The following courses are offered in conjunction with the above programs:

Department of Biological Sciences:

| | | | |
|---------|---------------------------------|---------|-----|
| 162 | Ichthyology | F | 3 |
| 163 | Marine Ecology | F | 3 |
| 173 | Principles of Fisheries Biology | F | 3 |
| 273 | Advanced Fishery Biology | Sp | 3 |
| 196 | Proseminar | F | 2 |
| 296 | Seminar | Sp | 2 |
| 199/299 | Special Problems | F or Sp | 2 |
| 500 | Master's Thesis | F or Sp | 2-4 |

Department of Physics—Physical Sciences:

Geology:

| | | | |
|-----|----------------------|---------|-----|
| 101 | General Oceanography | Sp | 3 |
| 196 | Seminar | F or Sp | 1-4 |
| 199 | Special Problems | F or Sp | 1-3 |

Moss Landing Marine Laboratories offers approximately a dozen courses in this field, as well as seminars, workshops, and research.

The instructional staff for the courses listed above consists of the following:

Department of Biological Sciences

Brittan, Martin R., Ph.D., Professor of Biological Sciences
 Meeker, Gary L., Ph.D., Assistant Professor of Biological Sciences
 Schinske, Robert, M.S., Associate Professor of Biological Sciences
 Vanicek, C. David, Ph.D., Assistant Professor of Biological Sciences

Department of Physics-Physical Sciences

Janke, Norman C., Ph.D., Associate Professor of Physical Sciences

To obtain further information, address all inquiries directly to:
Chairman, Department of Biological Sciences
Sacramento State College
Sacramento, California 95819

SALEM STATE COLLEGE
Salem, Massachusetts

Present facilities at Salem include classroom and laboratory facilities in the Arts and Science building on campus. A new science wing to this building is presently under construction.

No degrees are presently specifically offered in the marine sciences. Students in the Liberal Arts Program may major in biology and select from among the following marine science courses:

| | | | |
|--------|-----------------|----|---|
| BI 320 | General Ecology | F | 4 |
| BI 322 | Oceanology | Sp | 4 |
| BI 317 | Marine Botany | Su | 4 |
| BI 318 | Marine Ecology | Su | 4 |

The instructional staff for the courses listed above consists of the following:

Department of Biology

Moore, Johnes K., Ph.D., Assistant Professor of Biology

Paine, Claire M., Ph.D., Associate Professor of Biology

Schooley, James L., Ph.D., Professor of Biology

Sweeny, Edward F., Ph.D. (exp. 1969), Associate Professor of Biology

Sullivan, Frank L., M.A., Assistant Professor of Biology

Terrell, Charles R., M.S., Instructor

To obtain further information, address all inquiries directly to:

Professor Thomas I. Ryan, Chairman
Department of Biology
Salem State College
Salem, Massachusetts 01970

SAN DIEGO STATE COLLEGE San Diego, California

Marine sciences course and research programs are conducted primarily at the main campus, located 10 miles from the coast. Docking facilities are maintained in Mission Bay. Active course and research programs in the marine sciences are coordinated by an interdisciplinary Bureau of Marine Sciences. All departments have modern, well-equipped classroom, laboratory, and shop facilities. Provisions for marine instruction and research include standard physical and biological oceanographic equipment, laboratories for the analysis of sea water and sediment characteristics, radioisotope and electron microscope facilities, constant temperature rooms, and closed-system sea water aquaria. Computer facilities are available on the campus. Library holdings are well represented in the marine sciences and the extensive marine sciences library of the Scripps Institution is readily accessible. Several small craft, one equipped with a fathometer and hydrographic winch, are available for coastal sampling operations. The use of oceanographic vessels and other specialized facilities can be arranged in cooperation with the Scripps Institution of Oceanography and the Fishery-Oceanography Center of the U. S. Bureau of Commercial Fisheries.

The following degrees are offered in the basic sciences:

1. A.B. and B.S. in Biology, Botany, Chemistry, Geology, Physics, and Zoology; B.S. in Engineering

All students are required to fulfill the general education requirements of the college and to complete a series of core courses in their major field and in related areas of science and mathematics. Students are encouraged to obtain practical research experience through senior investigation and special studies courses.

2. M.A. and M.S. in Biology, Chemistry, and Physics; M.S. in Geology and Engineering disciplines

All students are required to obtain research experience and to demonstrate competence in their major field by satisfactorily completing a comprehensive examination and a thesis project. A student must complete 30 semester units of graduate course work with a grade point average of 3.0 (B) or better in order to qualify for the degree.

3. Ph.D. in Chemistry (offered jointly with the University of California, San Diego)

In order to qualify for this program, the student must be admitted to regular graduate standing by the University of California and San Diego State College. He must be prepared to take orientation examinations covering the fields of analytical, inorganic, organic, and physical chemistry, administered by a joint guidance committee. After formal admission to the program, the student must spend at least one year in full-time residence on each of the two campuses. A dissertation on a subject chosen by the student bearing on his field of specialization and showing his ability to conduct independent research is required of all candidates. A reading knowledge of two foreign languages also is required. A joint doctoral committee, consisting of three faculty members from each institution, conducts the qualifying and final oral examinations and guides the thesis research. The degree is awarded jointly by both institutions.

Courses in the marine sciences are offered during the regular academic year by the Departments of Biology, Botany, Chemistry, Engineering, Geology, Physical Science, Physics, and Zoology. Students are encouraged to specialize by taking marine science courses, and an interdisciplinary course sequence is being developed for this purpose under the auspices of the Bureau of Marine Sciences.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

Department of Biology

| | | | |
|-----|-----------------------------------|-------|-----|
| 109 | Regional Field Studies in Biology | Su | 1-3 |
| 110 | Ecology | F, Sp | 4 |
| 112 | Fisheries Biology | Sp | 3 |
| 113 | Biological Oceanography | F, Sp | 4 |
| 114 | Advanced Ecology | F, Sp | 3 |
| 175 | Statistical Methods in Biology | F | 3 |

| | | | |
|--|--|-------|------|
| Department of Biology—Continued | | | |
| 191 | Senior Investigation & Report in Ecology | | 2 |
| 198 | Methods of Investigation | | 2 |
| 199 | Special Study | | 1-6 |
| Department of Botany | | | |
| 101 | Phycology | F, Sp | 4 |
| 190 | Senior Investigation and Report | | 1 |
| 199 | Special Study | | 1-6 |
| Department of Zoology | | | |
| 105 | Invertebrate Embryology | | 3 |
| 112 | Marine Invertebrate Zoology | F, Sp | 4 |
| 115 | Ichthyology | F, Sp | 4 |
| 150 | Marine Biology | F, Sp | 3 |
| 170 | Animal Behavior | F, Sp | 3 |
| 190 | Senior Investigation & Report in Invertebrate Zoology | | 2 |
| 191 | Senior Investigation & Report in Vertebrate Zoology | | 2 |
| 198 | Methods of Investigation | | 2 |
| 199 | Special Study | | 1-6 |
| Department of Chemistry | | | |
| 196 | Selected Topics in Chemistry | | 1-3 |
| 198 | Senior Project | | 1-6 |
| 199 | Special Study | | 1-6 |
| Department of Geology | | | |
| 198 | Senior Research | | 3 |
| 199 | Special Study | | 1-4 |
| Department of Oceanography | | | |
| 100 | The Oceans | F, Sp | 2 |
| Department of Physical Science | | | |
| 110 | Physical Oceanography | F, Sp | 3 |
| 170A-B | Theoretical Oceanography | F, Sp | 3, 3 |
| 196 | Advanced Physical Science | F, Sp | 1-3 |
| 199 | Special Study | | 1-6 |
| Department of Physics | | | |
| 198 | Senior Research | | 1 |
| 199 | Special Study | | 1-6 |
| Department of Engineering | | | |
| 181 | Hydrodynamics | | 3 |
| GRADUATE COURSES | | | |
| Department of Biology | | | |
| 241 | Seminar in Aquatic Ecology | | 2 |
| 245 | Aquatic Ecology | | 3 |
| 291 | Investigation and Report | | 3 |
| 297 | Research | | 1-6 |
| 298 | Special Study | | 1-6 |
| 299 | Thesis | | 3 |
| Department of Botany | | | |
| 200 | Seminar | | 2 |
| 297 | Research | | 1-6 |
| 298 | Special Study | | 1-6 |
| 299 | Thesis | | 3 |

Department of Zoology

| | | |
|-----|--|-----|
| 200 | Seminar | 2-3 |
| 201 | Seminar in Marine Zoology | 2 |
| 206 | Seminar in the Biology of Cold-blooded Vertebrates | 2 |
| 212 | Advanced Marine Invertebrate Zoology | 3 |
| 291 | Research Techniques | 3 |
| 297 | Research | 1-6 |
| 298 | Special Study | 1-6 |
| 299 | Thesis | 3 |

Department of Chemistry

| | | |
|-----|------------------|-----|
| 200 | Seminar | 1-3 |
| 291 | Research Seminar | 1 |
| 297 | Research | 1-6 |
| 298 | Special Study | 1-6 |
| 299 | Thesis | 3 |

Department of Geology

| | | |
|-----|---------------|-----|
| 200 | Seminar | 2-3 |
| 297 | Research | 1-6 |
| 298 | Special Study | 1-3 |
| 299 | Thesis | 3 |

Department of Physical Science

| | | |
|-----|----------------------------------|-----|
| 200 | Seminar in Physical Oceanography | 2-3 |
| 298 | Special Study | 1-6 |
| 299 | Thesis | 3 |

Department of Physics

| | | |
|-----|---------------|-----|
| 200 | Seminar | 2-3 |
| 297 | Research | 1-6 |
| 298 | Special Study | 1-6 |
| 299 | Thesis | 3 |

Department of Engineering

| | | |
|-------|----------------------------------|-----|
| CE235 | Water Quality Engineering | 3 |
| CE236 | Water Quality Processes I | 3 |
| CE237 | Water Quality Processes II | 3 |
| CE283 | Seminar in Hydraulic Engineering | 2-3 |
| CE284 | Seminar in Sanitary Engineering | 2-3 |

The instructional staff for the courses listed above consists of the following:

Division of Life Sciences

Darby, Richard L., Ph.D., Assistant Professor of Biology
 Dexter, Deborah M., Ph.D., Assistant Professor of Zoology
 Farris, David A., Ph.D., Professor of Biology
 Ford, Richard F., Ph.D., Associate Professor of Biology
 Gallup, Avery H., Ph.D., Professor of Botany
 Hazen, William E., Ph.D., Professor of Biology
 Huffman, Edward W., Ph.D., Professor of Zoology
 McBlair, William, Ph.D., Professor of Biology
 McLean, Norman, Ph.D., Associate Professor of Zoology
 Todd, John, Ph.D., Assistant Professor of Zoology
 Wilson, Wilfred J., Ph.D., Associate Professor of Zoology

Division of Physical Sciences

Allison, Edwin C., Ph.D., Professor of Geology
 Berger, Wolfgang, Ph.D., Assistant Professor of Physical Science
 Berry, Richard W., Ph.D., Associate Professor of Geology

Division of Physical Sciences—Continued

Dessel, Norman F., Ph.D., Professor of Physical Sciences

Dill, Robert F., Ph.D., Lecturer in Biology

Ingmanson, Dale, Ed.D., Assistant Professor of Physical Science

Mathewson, James H., Ph.D., Associate Professor of Chemistry

Moe, Chesney R., Ph.D., Professor of Physics

Phleger, Charles, Ph.D. candidate, Assistant Professor of Physical Science

Riffenburgh, Robert, Ph.D., Professor of Physical Science

School of Engineering

Chang, Hai-Yain, Ph.D., Assistant Professor of Aerospace Engineering

Morgan, Chalres, M.S., Professor of Mechanical Engineering

Noorany, Irag, Ph.D., Professor of Civil Engineering

Quiett, Frederick T., M.S., Professor of Civil Engineering

Stratton, Frank E., Ph.D., Associate Professor of Civil Engineering

To obtain further information, address all inquiries directly to:

Director, Bureau of Marine Sciences

San Diego State College

5402 College Avenue

San Diego, California 92115

SAN FRANCISCO STATE COLLEGE
San Francisco, California

Classroom and laboratory facilities are available at the main campus in San Francisco for studies in invertebrate and vertebrate zoology, marine botany, and marine microbiology. There are also facilities for graduate studies in ecology, functional morphology, systematics, physiology, and ethology. The College enjoys a close working relationship with the nearby California Academy of Sciences where qualified students may take advantage of the valuable library and the large collections of fishes, invertebrates, and other materials for studies in systematics and morphology. San Francisco State College, in cooperation with four other California State Colleges, operates Moss Landing Marine Laboratory as a sea-side campus extension (for a detailed description of the Moss Landing facilities, refer to the Consortia section).

The college offers an M.A. in Biology with a concentration in Marine Biology through the Department of Marine Biology. Each student is required to complete a total of thirty (30) semester units, selected with the approval of a marine biology advisor. Courses are to consist of upper division and graduate courses with a minimum of twelve (12) units of graduate courses. At least one course must be taken at an approved marine station. Of graduate courses, at least two must be seminar courses. A minimum of three (3) (maximum of six (6)) units of research courses is required. A thesis is required (an oral or written examination may be substituted in exceptional cases) for which a student may take a maximum of six (6) thesis research units.

The following courses are offered in conjunction with the above program:

Department of Marine Biology

| | | | |
|-----------|---|----|---|
| Biol. 111 | Biological Oceanology | Sp | 3 |
| Biol. 141 | Introductory Fishery Biology | F | 4 |
| Biol. 165 | Marine Science Diver Training | | 2 |
| Biol. 187 | Marine Zoogeography | Sp | 2 |
| Bot. 107 | Algology | Sp | 4 |
| Geog. 115 | Oceanography | F | 3 |
| Geog. 116 | The Geography of Marine Resources | | 3 |
| Zool. 113 | Marine Invertebrate Zoology | F | 4 |
| Zool. 114 | Natural History of the Marine Invertebrates | Sp | 4 |
| Zool. 115 | Marine Invertebrate Physiology | F | 3 |
| Zool. 160 | Introductory Ichthyology | F | 3 |
| Zool. 223 | Ecology of Estuaries and Lagoons | | 3 |

The instructional staff for the courses listed above consists of the following:

Department of Geography

Eydal, Astvaldur, Ph.D., Associate Professor of Geography

Department of Marine Biology

Beeman, Robert D., Ph.D., Associate Professor of Biology and Chairman of the Department

Araki, George S., Ph.D., Associate Professor of Biology

Berrend, Robert E., Ph.D., Associate Professor of Biology

Bowen, Sarane T., Ph.D., Associate Professor of Biology

Bradbury, Margaret G., Ph.D., Associate Professor of Biology

Gustafson, Joel F., Ph.D., Professor of Biology

Hensill, John S., Ph.D., Professor of Biology and Dean of the School of Natural Sciences

Herald, Earl S., Ph.D., Lecturer in Biology

Newcombe, Curtis L., Ph.D., Professor of Biology

Oberlander, George T., Ph.D., Professor of Biology

Swan, Lawrence W., Ph.D., Professor of Biology

Tomlinson, Jack T., Ph.D., Professor of Biology

Towle, Albert, Ph.D., Professor of Biology

Department of Marine Biology—Continued

Treichel, Georg, B.A., Lecturer in Human Ecology

Zullo, Victor A., Ph.D., Lecturer in Biology

Department of Microbiology

Yonemaka, Hideo H., Ph.D., Associate Professor of Biology

To obtain further information, address all inquiries directly to:

Chairman, Department of Marine Biology

San Francisco State College

1600 Holloway Ave.

San Francisco, California 94132

SAN JOSE STATE COLLEGE
San Jose, California

Classes are conducted both on the main campus in San Jose and at the seashore station, The Moss Landing Marine Laboratories (a description of the Moss Landing facilities can be found in the Consortium section). A science building housing the geology, meteorology, chemistry and physical science departments was completed in 1967. Facilities on the geology floors include 2 geophysics laboratories, one sedimentation and one micropaleontology laboratory. Mineralogy laboratory and equipment are also at the disposal of students both for research and teaching purposes. A new science building for biological sciences will be completed in 1970. A separate map room with complete coverage of the ocean floor and a collection room for samples and cores for study of ocean floor sediments are also part of the facility. The computing center has also been under continuous expansion; a new Control Data 3300 computer has been installed and will boost the computing facilities which are available both for faculty and student research.

The following degrees are offered in the areas indicated:

1. Bachelor of Science with option in Oceanography
2. Master of Science (thesis required)

Students may specialize in any of the following fields: Geophysics, Geochemistry, Geological, Chemical, or Biological Oceanography.

An interdisciplinary approach to oceanography is emphasized in the undergraduate and graduate training programs. At the undergraduate level, training is done through oceanography options for each regular science major, e.g., chemistry, geology, biology, etc. At the graduate level, training is tailored to the student for the Master's Degree; theses are required.

The following courses are offered in conjunction with the above programs (all specialized courses are upper division and graduate courses):

| | | |
|------------|-----------------------------------|---|
| Geol. 129 | General Oceanography | 4 |
| Geol. 111 | Geophysics | 3 |
| Geol. 115 | Geochemistry | 3 |
| Geol. 113 | Micropaleontology | 3 |
| Geol. 141 | Geological Oceanography | 4 |
| Geol. 142 | Marine Biogenic Sediments | 3 |
| Geol. 143 | The Margin of the Oceans | 2 |
| Geol. 196 | Marine Science Techniques | 1 |
| Biol. 111 | Zoology of Marine Vertebrates | 4 |
| Biol. 121 | Marine Invertebrate Zoology | 4 |
| Biol. 131 | Marine Algology | 3 |
| Biol. 141 | Biological Oceanography | 3 |
| Biol. 161 | Marine Ecology | 3 |
| Biol. 181 | Literature of the Marine Sciences | 1 |
| Chem. 141 | Chemical Oceanography | 3 |
| Phys. 141 | Physical Oceanography | 3 |
| Meteo. 135 | Meteorology of the Oceans | 3 |

The instructional staff for the courses listed above consists of the following:

Biology Department

Bell, Charles, Ph.D., Associate Professor of Biology
 Harville, John, Ph.D., Professor of Biology and Marine Science
 Kenk, Vida, M.S., Assistant Professor
 McMaster, Pauline, M.A., Associate Professor of Invertebrate Zoology
 Morejohn, Victor, Ph.D., Professor of Biology

Chemistry Department

Stump, Arthur, Ph.D., Assistant Professor of Chemical Oceanography

Geology Department

Arnal, Robert E., Ph.D., Professor of Geology

Brooke, John P., Ph.D., Assistant Professor of Geophysics

Dolloff, Norman H., Ph.D., Professor of Geology

Stevens, Calvin H., Ph.D., Associate Professor of Geology

Meteorology Department

Miller, Albert, Ph.D., Professor of Meteorology

Read, Robert, M.S., Associate Professor of Marine Meteorology

To obtain further information, address all inquiries directly to:

Dr. Robert E. Arnal (for physical sciences)

Geology Department

San Jose State College

San Jose, California 95114

Dr. John Harville (for biological sciences)

Biology Department

San Jose State College

San Jose, California 95114

Moss Landing Marine Lab.

P. O. Box 223

Moss Landing, California 95039

**SCRIPPS INSTITUTION OF OCEANOGRAPHY
UNIVERSITY OF CALIFORNIA, SAN DIEGO
La Jolla, California**

Since 1912 the Scripps Institution of Oceanography has been a unit of the University of California. Now part of the University of California San Diego campus, the nine buildings of the Scripps Institution are clustered on the ocean shore north of the center of La Jolla, a suburb of San Diego. The SIO Library, a unit of the University Library, contains more than 70,000 volumes, 87,000 reports and reprints, 3,000 serials, and a large collection of charts. Special facilities are as follows: Radio station WWD, operated by the U. S. Bureau of Commercial Fisheries; the Scripps Pier, 1,000 feet long, housing apparatus for a number of serial oceanographic observations, and used as a landing place for skiffs; the salt water system providing clean sea water to the aquarium and biological laboratories; an underwater area for research and collecting offshore from the Institution; deep-sea sediment cores from several thousand widely scattered localities in the world ocean; original echograms along several thousand widely scattered localities in the world ocean; original echograms along several hundred thousand miles of ships' tracks in the Pacific; Carbon-14 and tritium laboratories; an oceanographic data archive of some half a million bathythermograph (BT) observations; an electron microprobe laboratory; six mass spectrographs; several thousand samples of sea water from the world oceans; an electron microscope laboratory; the Scripps fish collection of more than 750,000 specimens of some 2,000 species of marine fish; oceanic samples of plankton. Scripps scientists have access to the University's computer center. The Institution operates eight ships specially fitted for oceanographic research: ALEXANDER AGASSIZ, ARGO, FLIP (Stable research platform), ALPHA HELIX, OCONOSTOTA, E. B. SCRIPPS, WASHINGTON, MELVILLE.

Scripps offer the degrees of Ph.D. in Oceanography, Ph.D. in Marine Biology, and Ph.D. in Earth Sciences. The program of study for the Ph.D. degree is determined in consultation with the student's adviser. The Department has no formal language requirements. Students are expected to have satisfied the entrance requirement of preparation in at least one important language. Within the Department, curricular programs may require demonstration of ability to use certain foreign languages pertinent to a student's research. All students are normally required to take a departmental examination, and the student will be required to demonstrate his comprehension of required subject material and of the pertinent interactions of physical, chemical, biological or geological factors. After the student has passed the departmental examination, and has completed an appropriate period of additional study the Department will recommend appointment of a doctoral committee. This committee will determine the student's qualifications for independent research by means of a Qualifying Examination and will supervise the student's performance and reporting of his research. A requirement for the Ph.D. degree is the submission of a dissertation and a final examination in which the thesis is publicly defended.

The Department does not encourage students who wish to proceed only to the M.S. If circumstances warrant, the degree is normally offered under Plan II (comprehensive examination) after completion of course work established by the department.

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

Upper-Division Courses

| | | | |
|-------------------------|---|--------------|------|
| 199 | Special Studies | F, W, Sp | 1-4 |
| Graduate Courses | | | |
| 207A, B | Problems in General and Physical Oceanography | W, Sp | 2, 2 |
| 208 | Oceanography Field Course | F, W, Sp, Su | 2-4 |
| 209 | Special Topics | F, W, Sp | 1-4 |
| 210A | Physical Oceanography | F | 3 |
| 210B | Physical Oceanography | W | 3 |
| 211A, B | Ocean Waves | W, Sp | 3, 3 |
| 212A | Dynamical Oceanography | F | 3 |
| 212B | Dynamical Oceanography | Sp | 3 |

Graduate Courses—Continued

| | | | |
|---------|---|----------|------|
| 213A, B | Radiative Transfer in the Sea | F, W | 2–3 |
| 216A, B | Physics of Sediment Transport | W, Sp | 3, 3 |
| 219 | Special Topics in Physical Oceanography | F, W, Sp | 1–4 |
| 220 | Topics in Geophysical Continuum Mechanics | F | 3 |
| 221 | Topics in Geophysical Fluid Dynamics | W | 3 |
| 222A, B | Hydrodynamics | W, Sp | 3, 3 |
| 223 | Geophysical Measurements | Sp | 3 |
| 224 | Geophysical Random Processes | Sp | 3 |
| 225 | Tides and the Rotation of the Earth | W | 3 |
| 226A, B | Internal Constitution of the Earth | W, Sp | 3, 3 |
| 227 | Seismology | Sp | 3 |
| 228 | Gravity and Geomagnetism | W | 3 |
| 240 | Marine Geology | W | 3 |
| 242A, B | Marine Micropaleontology | W, Sp | 3, 3 |
| 243 | Marine Stratigraphy | Sp | 3 |
| 244 | Marine Geophysics | W | 3 |
| 245 | Sedimentary Petrology | F | 3 |
| 246 | Minerals and Processes of Sediments | W | 3 |
| 247 | Tectonics | Sp* | 3 |
| 248 | Seminar in Marine Geology | F, W, Sp | 2 |
| 249 | Special Topics in Marine Geology | F, W, Sp | 1–4 |
| 251A | Thermodynamics of Natural Processes | Sp* | 3 |
| 251B | Nuclear Geochemistry | W* | 3 |
| 252 | Cosmochemistry | F* | 3 |
| 253 | Experimental Petrology | F | 3 |
| 254 | Igneous Petrology | W* | 3 |
| 255 | Crustal Evolution | Sp* | 3 |
| 256 | Earth Sciences Summer Field Course | Su | 6 |
| 257 | Seminar in Petrology | F, W, Sp | 3 |
| 258 | Seminar in Geology | F, W, Sp | 3 |
| 259 | Seminar in Geochemistry | F, W, Sp | 3 |
| 260 | Marine Chemistry | F | 3 |
| 261 | Physical Chemistry of Sea Water | F | 3 |
| 262 | Major Sedimentary Cycle | W | 3 |
| 263 | Major Chemical Cycles in the Sea | Sp | 3 |
| 264 | Solids in Nature | Sp* | 3 |
| 269 | Special Topics in Marine Chemistry | F, W, Sp | 1–4 |
| 270A | Biological Oceanography: Environment and Organisms | F | 3 |
| 270B | Biological Oceanography: Processes and Events | W | 3 |
| 271A | Laboratory in Biological Oceanography | F | 2 |
| 271B | Laboratory in Biological Productivity | W | 2 |
| 272 | Oceanic Zoogeography | Sp* | 3 |
| 273 | Introduction to Animal Behavior | F | 3 |
| 274 | Population Dynamics | F* | 3 |
| 275A, B | Marine Ecology | W, Sp* | 3, 3 |
| 276A, B | Applied Statistics | W, Sp* | 3, 3 |
| 278 | Problems in Biological Oceanography | F | 2 |
| 279 | Special Topics in Biological Oceanography | F, W, Sp | 1–4 |

*Offered in alternate years.

Graduate Courses—Continued

| | | | |
|---------|---|----------|---------|
| 280A, B | Marine Biology | F, W, Sp | 3, 3, 3 |
| 282A, B | Advanced Invertebrate Zoology | F, W | 3, 3 |
| 283 | Biology of Fishes | Sp | 4 |
| 284 | Seminar in Advanced Ichthyology | F, W | 2 |
| 285 | Biology of Algae | F | 2 |
| 286 | Marine Microbiology | F | 3 |
| 287A, B | Shore Microbiology | W, Sp | 3, 3 |
| 289 | Special Topics in Marine Biology | F, W, Sp | 1-4 |
| 290 | Cellular Structure and Biochemical Function | Sp | 3 |
| 291A | Marine Biochemistry | W | 3 |
| 291B | Marine Biochemistry | Sp | 3 |
| 292A, B | Physiology of Marine Animals | W, Sp | 3, 3 |
| 293 | Physiology of Marine Algae | F | 3 |
| 294 | Selected Topics in Environmental Physiology | F | 6 |
| 295 | Laboratory in Physiology | Sp | 4 |
| 296 | Isotope Tracer Techniques in Physiology | Sp | 2 |
| 298 | Marine Biology Seminar | F, W, Sp | 1 |
| 299 | Research | F, W, Sp | 1-12 |

The instructional staff for the courses listed above consists of the following:

Winterer, Edward L., Ph.D., Chairman and Professor of Geology
 Arrhenius, Gustaf, D.Sc., Professor of Marine Geology
 Arthur, Robert S., Ph.D., Professor of Oceanography
 Backus, George E., Ph.D., Professor of Geophysics
 Benson, Andrew A., Ph.D., Professor of Biology
 Brinton, Edward, Ph.D., Lecturer in Oceanography
 Bullard, Edward C., F.R.S., Sc.D., Professor of Geophysics
 Bullock, Theodore H., Ph.D., Professor of Neurophysiology
 Cox, Charles S., Ph.D., Professor of Oceanography
 Craig, Harmon, Ph.D., Professor of Geochemistry
 Curray, Joseph R., Ph.D., Associate Professor of Oceanography
 Davis, Russ E., Ph.D., Assistant Professor of Geophysics
 Duntley, Seibert Q., Ph.D., Professor of Physics
 Eckart, Carl H., Ph.D., Professor of Geophysics
 Engel, Albert E. J., Ph.D., Professor of Geology
 Enns, Theodore, Ph.D., Lecturer in Marine Biology
 Enright, James T., Ph.D., Associate Professor of Oceanography
 Fager, Edward W., Ph.D., D. Phil., Professor of Marine Ecology
 Faulkner, David J., Ph.D., Assistant Professor of Oceanography
 Fisher, Frederick H., Ph.D., Lecturer in Marine Chemistry
 Fleminger, Abraham, Ph.D., Lecturer in Marine Biology
 Fox, Denis L., Ph.D., Professor of Marine Biochemistry
 Gibson, Carl H., Ph.D., Assistant Professor of Aerospace Engineering
 Gieskes, Joris M. T., Ph.D., Assistant Professor of Oceanography
 Gilbert, J. Freeman, Ph.D., Professor of Geophysics
 Goldberg, Edward D., Ph.D., Professor of Chemistry
 Hagiwara, Susumu, M.D., Ph.D., Professor of Physiology
 Hammel, Harold T., Ph.D., Professor of Physiology
 Haubrich, Richard A., Ph.D., Associate Professor of Geophysics
 Hawkins, James W., Ph.D., Assistant Professor of Geology
 Haxo, Francis T., Ph.D., Professor of Biology
 Hendershott, Myrl, Ph.D., Assistant Professor of Oceanography
 Hessler, Robert R., Ph.D., Associate Professor of Oceanography

Holland, Nicholas D., Ph.D., Assistant Professor of Marine Biology
 Inman, Douglas L., Ph.D., Professor of Oceanography
 Isaacs, John D., B.S., Professor of Oceanography
 Keeling, Charles D., Ph.D., Professor of Oceanography
 Lewin, Ralph A., Ph.D., Professor of Biology
 MacIntyre, Ferren, Ph.D., Assistant Professor of Oceanography
 McGowan, John A., Ph.D., Associate Professor of Oceanography
 Menard, Henry W., Ph.D., Professor of Geology
 Mullin, Michael M., Ph.D., Assistant Professor of Oceanography
 Munk, Walter H., Ph.D., Professor of Geophysics
 Newman, William A., Ph.D., Assistant Professor of Oceanography
 Nierenberg, William A., Ph.D., Professor of Physics, Dean and Director, Scripps Institution of
 Oceanography
 Owen, Benton B., Ph.D., Lecturer in Marine Chemistry
 Parker, Robert L., Ph.D., Assistant Professor of Geophysics
 Peterson, Melvin N. A., Ph.D., Associate Professor of Oceanography
 Phleger, Fred B., Ph.D., Professor of Oceanography
 Preisendorfer, R. W., Ph.D., Lecturer in Geophysics
 Raitt, Russell W., Ph.D., Professor of Geophysics
 Reid, Joseph L., M.S., Lecturer in Oceanography
 Riedel, William R., M.S., Lecturer in Oceanography
 Rosenblatt, Richard H., Ph.D., Associate Professor of Marine Biology; Vice-Chairman
 Schaefer, Milner B., Ph.D., Professor of Oceanography
 Scholander, Per F., M.D., Ph.D., Professor of Physiology
 Shor, George G., Jr., Ph.D., Lecturer in Oceanography
 Spiess, Fred N., Ph.D., Professor of Oceanography
 Strickland, John D. H., Ph.D., Lecturer in Oceanography
 Taft, Bruce A., Ph.D., Assistant Professor of Oceanography
 Vacquier, Victor, M.A., Professor of Earth Sciences
 Van Atta, Charles W., Ph.D., Assistant Professor of Aerospace Engineering
 Wooster, Warren S., Ph.D., Professor of Oceanography
 Volcani, Benjamin A., Ph.D., Professor of Microbiology
 ZoBell, Claude E., Ph.D., Professor of Marine Microbiology
 To obtain further information, address all inquiries directly to:
 Graduate Department
 Scripps Institution of Oceanography
 Box 109
 La Jolla, California 92037

UNIVERSITY OF SOUTHERN MISSISSIPPI Hattiesburg, Mississippi

The Department of Biology offers a variety of courses which cover both marine biology and biological oceanography. Currently the department operates in an area of 35,000 square feet representing both labs and classrooms. The University is closely affiliated with the Gulf Coast Research Laboratory at Ocean Springs, Mississippi (only 90 miles away). This association allows use of the research vessels HERMES and GULF RESEARCHER which belong to GCRL. The department also utilizes the facilities of the Bureau of Commercial Fisheries' vessel, R/V OREGON II, on a space available basis.

The Department of Geology, which occupies 18,000 square feet of laboratories, offices, and classrooms in the Science Building also cooperates closely with the GCRL and is extended the use of GCRL facilities.

The following degrees are offered in the basic sciences:

1. Ph.D. in Marine Biology (Department of Biology). The Department of Biology offers a Doctor of Philosophy degree with majors in marine biology and in zoology. Candidates for doctoral degrees must earn a minimum of 118 quarter hours of credit beyond the baccalaureate degree, or 72 quarter hours of credit beyond the master's degree. Forty-eight quarter hours must be spent on the Hattiesburg campus. A candidate is admitted to the doctoral program conditionally upon completion of a qualifying entrance examination which is administered during the first quarter on the main campus, and after successfully demonstrating a reading knowledge of two foreign languages. Candidates are admitted to candidacy for the degree only after successfully passing a comprehensive examination which is administered at or near completion of the course work, after completion of the language requirement and at least one year prior to graduation. A final oral examination is administered after the dissertation has been accepted.

2. M.A., M.S. in Biology (Department of Biology). Candidates for the Master of Arts or Master of Science degrees must earn 46 quarter hours of graduate credit. For the Master of Arts degree a candidate must take 16 hours of an approved academic minor, must demonstrate proficiency in a foreign language and write a thesis. For the Master of Science degree a candidate must elect a minor in an approved field and a major from biology, zoology, botany, microbiology, or marine biology, and write a thesis. The candidate must complete a Graduate Record Examination before acceptance as a graduate student. An English Proficiency Examination and a Comprehensive Examination are also required. The comprehensive examination is also a defense of thesis.

3. M.A., M.S. in Geology (Department of Geology). Candidates for the Master of Arts or Master of Science degrees must earn 46 quarter hours of graduate credit. For the Master of Arts degree a candidate must take 16 hours of an approved academic minor, demonstrate proficiency in a foreign language, and present an acceptable thesis. For the Master of Science degree, a candidate must elect a minor (16 hours) in an approved field and present an acceptable thesis. A departmental evaluation examination is required during the candidate's first quarter of residence, and he must present a combined Graduate Record examination score of 850 or higher for admission to degree candidacy; an English Proficiency Examination is also required, as well as a defense of thesis.

Marine science courses are offered by the Departments of Biology and Geology during the regular academic year. Summer courses in marine biology and geology are offered at the Gulf Coast Research Laboratory. Credits are in quarter hours.

Department of Biology

| | | |
|-----|---|-----|
| 448 | Comparative Animal Physiology | 4 |
| 479 | Introduction to Biological Oceanography | 4 |
| 429 | Marine Botany (GCRL) | 4.5 |
| 431 | Marine Vertebrate Zoology (GCRL) | 9 |
| 454 | Marine Invertebrate Zoology (GCRL) | 9 |
| 515 | Biological Oceanography | 4 |
| 567 | Marine Ecology | 4 |
| 568 | Planktology | 4 |

Department of Biology—Continued

| | | |
|-----|--|----------|
| 600 | Advanced Problems in Marine Microbiology | 6 |
| 604 | Research in Marine Biology | Arranged |
| 798 | Dissertation | |

Department of Geology

| | | |
|-----|---|---|
| 452 | Physical Marine Geology (GCPL) | 9 |
| 453 | Chemical Marine Geology (GCRL) | 9 |
| 454 | Problems in Marine Sedimentation (GCRL) | 9 |
| 479 | Introduction to Geological Oceanography | 4 |
| 485 | Problems in Geology | 4 |

The instructional staff for the courses listed above consists of the following:

Department of Biology

Stocks, Peter K., Ph.D., Acting Chairman and Associate Professor of Biology
Cliburn, Joseph W., Ph.D., Professor of Biology
Harrises, Antonio E., Ph.D., Professor of Biology
Walker, James F., Ph.D., Professor of Biology
Fish, Arthur G., Ph.D., Assistant Professor of Biology
Fischer, Barbara A., Ph.D., Assistant Professor of Biology
Pessoney, George F., Ph.D., Assistant Professor of Biology

Department of Geology

Bowen, Richard L., Ph.D., Chairman and Professor of Geology
Paulson, Oscar L., Ph.D., Associate Professor of Geology

To obtain further information, address all inquiries directly to:

Department of Biology

Dr. Peter K. Stocks
Acting Chairman, Department of Biology
University of Southern Mississippi
Hattiesburg, Mississippi 39401

Department of Geology

Dr. R. L. Bowen
Chairman, Department of Geology
University of Southern Mississippi
Hattiesburg, Mississippi 39401

HOPKINS MARINE STATION OF STANFORD UNIVERSITY

Pacific Grove, California

The Station occupies an exposed rocky headland, Mussel Point. The University holds title to about 11 acres on and around the point, which includes approximately one mile of shoreline. The intertidal and offshore waters surrounding the Marine Station, rich in marine life, are protected by law as a marine reserve, and provide excellent resources for research and teaching in marine biology. The Station operates as a branch of the Department of Biological Sciences of the University. The teaching and research facilities at the Station are housed in three main buildings. The Agassiz Laboratory provides space and equipment for studies in the biology and ecology of marine invertebrates, fishes and algae. A three-story concrete structure, it contains three large teaching laboratories and office and research space for staff, graduate students, and visiting investigators. Special facilities include rooms equipped for microtechnique and photomicrography, a large aquarium room, a reference collection of marine invertebrates, and the Gilbert M. Smith herbarium of marine algae. The two-story Jacques Loeb Laboratory provides rooms and other facilities for experimental studies on the development, physiology, and biochemistry of marine animals, plants, and microorganisms. Cold rooms, constant temperature rooms, and a photographic darkroom are available. The laboratories are equipped with a wide variety of specialized equipment including a gas chromatograph, recording spectrophotometers, radiation counting equipment, high speed refrigerated centrifuges, a preparative ultracentrifuge, neurophysiological equipment, and facilities for electrophoresis and chromatography. The Marinostat houses two large laboratories, 10 smaller research rooms, and six dark laboratories now being equipped for experimental temperature and light regimes. In addition to seawater at normal ocean temperatures, all laboratories are supplied with refrigerated seawater for maintaining lower temperatures. The library is housed on the upper floor of the Jacques Loeb Laboratory. It contains a constantly expanding collection of books in the fields most under study (algology, invertebrate zoology, development, ecology, physiology, biochemistry, microbiology, and biological oceanography). The collection currently consists of some 12,000 volumes. About 450 serial publications in these fields are received.

The research vessel **PROTEUS**, a 96-foot motor vessel with a 6000 mile range, provides the base for graduate training in biological oceanography. The ship carries a scientific party of 9 and is outfitted as a floating laboratory for observation, collection, experimentation, and teaching. Deepsea trawling and hydrographic winches permit sampling at depths of up to 6000 meters. The ship is equipped with a variety of gear for physical measurement, chemical analysis, and the collection, examination, and maintenance of living organisms. In addition a small reference library is carried which is changed to suit the needs of each cruise. Several skiffs and a launch and diving equipment are carried for inshore work.

Two smaller research vessels, the **TAGE**, a 40.5-foot launch, and a 26-foot whaler are equipped with winches and oceanographic equipment for more limited studies in Monterey Bay. Several small skiffs are available for inshore work.

The Station offers the degree of **Doctor of Philosophy in Biology**, with specialization in algology, invertebrate zoology, development, ecology, physiology, biochemistry, or biological oceanography.

In addition the Station provides: (a) courses in marine biology and biological oceanography designed for matriculated and non-matriculated undergraduates and graduate and professional biologists during the summer quarter; (b) a program of training in research for matriculated and non-matriculated undergraduates and graduates in biology during the spring (Biology 175H) and summer quarters (Biology 176H and 199H)—students after completion of Biology 175H may continue their research during the summer by enrolling in Biology 176H or 199H; (c) a program of graduate study and research in marine biology and biological oceanography leading to the degrees of Master of Arts and Doctor of Philosophy during all four quarters.

The following courses are offered in conjunction with the above programs:

| | |
|------|----------------------|
| 100H | Marine Algae |
| 101H | Physiology of Algae |
| 111H | Marine Invertebrates |

| | |
|------|---|
| 112H | Marine Invertebrates (continued) |
| 117H | Zooplankton |
| 119H | Marine Ecology |
| 120H | Marine Ecology (continued) |
| 147H | Comparative and Experimental Embryology |
| 148H | Comparative and Experimental Embryology (continued) |
| 176H | Problems in Biological Oceanography |
| 199H | Special Problems |
| 222H | Biological Oceanography |
| 261H | Comparative Biochemistry of Marine Organisms |
| 269H | Ecological Physiology |
| 300H | Research |

The instructional staff for the courses listed above consists of the following:

Abbott, Donald Putnam, Ph.D., Professor of Biology and Associate Director, Hopkins Marine Station

Abbott, Isabella Aiona, Ph.D., Research Biologist

Blinks, Lawrence Rogers, Ph.D., Acting Professor of Biology, Emeritus

Epel, David, Ph.D., Assistant Professor of Biology

Giese, Arthur Charles, Ph.D., Professor of Biology

Gilmartin, Malvern, Ph.D., Professor of Biology

Lee, Welton Lincoln, Ph.D., Professor of Biology, Director, Hopkins Marine Station

Wheeler, Ellsworth Haines, Ph.D., Acting Assistant Professor of Biology

Womersley, H. B. S., Ph.D., Acting Associate Professor of Biology

To obtain further information, address all inquiries directly to:

John H. Phillips, Director

Hopkins Marine Station

Pacific Grove, California 93950

TEXAS A&M UNIVERSITY
College Station, Texas

The University's Department of Oceanography is housed in two buildings on the main campus in College Station. The facilities available to students include the Texas A&M Marine Laboratory at Galveston and the fully-equipped 180-foot research vessel R/V ALAMINOS.

The University offers the degrees of Ph.D. in Oceanography and M.S. in Oceanography through its Department of Oceanography.

A student in the Ph.D. program will, after admission to graduate study, consult the head of his major or administrative department concerning appointment of his advisory committee. This committee will consist of not less than five members of the Graduate Faculty representative of the student's several fields of study and research; two of the members must be from disciplines outside the major field.

The committee will evaluate the student's previous training and degree objectives. They will then outline a degree program and research problem which, with the dissertation, will constitute the basic requirements for the degree. The degree program will be submitted on standard forms for the approval of the Dean of the Graduate College, who will, at the time of approval, appoint a representative of the Graduate Council to the student's committee. The field of study may be chiefly in one department or may be in a combination of departments. The chairman of the committee will normally have immediate supervision of the student's research and dissertation. The degree program should be submitted before the second registration after a student enters into graduate study.

To qualify for the preliminary examination, the student must have satisfied the language requirements and have completed all but approximately six hours of the formal course work on the Degree Program, excluding 691 (Dissertation Research). The examination shall be both oral and written unless otherwise recommended by the student's committee and the Graduate Council Representative and approved by the Dean of the Graduate College. The written part of the examination will cover each field of study included in the student's program and both parts of the examination must be completed within a length of time approved by the Dean of the Graduate College, usually not exceeding two weeks. Credit for the preliminary examination is not transferable.

The general field of research to be used for the dissertation should be agreed on by the student and his committee at their first meeting, as a basis for selecting the proper courses to support the proposed research.

In the M.S. program, the student's committee, in consultation with the student, will develop his Degree Program. This should be completed and filed with the Dean of the Graduate College, whose approval is required, prior to the second registration.

This Degree Program must be submitted on the official form with endorsements by the student's advisory committee. Any prerequisite courses recommended should also be listed on the form.

The student must prepare a thesis proposal for approval by his committee. This proposal must be submitted for the approval of the Dean of the Graduate College at least 14 weeks prior to the close of the semester or summer session in which the student expects to receive his degree.

A minimum of two full semesters of approved courses and research (32 semester hours) is required for the Master of Science degree.

Ordinarily the student will devote the major portion of this time to work in one field or two closely related fields. Other work will be in supporting fields of interest. In general, not less than one third of the course work, exclusive of research, should be taken in one or more fields outside the major field.

Specialization may be undertaken for both the M.S. and Ph.D. degrees in biological, chemical, geological, meteorological, and physical oceanography. It is also possible for certain students with undergraduate degrees in engineering to substitute engineering course work for up to 15 semester hours of prerequisites for the discipline in which advanced work is desired. Such a program usually consists of the regular physical oceanography program with a minor in engineering. Students may also enroll in pertinent courses offered in other departments, e.g.: Geology and Geophysics, Biology, Mathematics, and Physics among others. An effort is made to maintain a balance between the biological, chemical, geological and physical aspects of oceanography both in teaching and research.

The following courses are offered in conjunction with the above programs:

| | | |
|--------|---------------------------------------|-----|
| 205 | Survey of Oceanography | 1 |
| 401 | Introduction of Oceanography | 3 |
| 603 | Sea Laboratory Techniques | 1 |
| 608 | Physical Oceanography | 4 |
| 609 | Physical Oceanography | 3 |
| 611 | Theoretical Physical Oceanography | 3 |
| 612 | Elements of Ocean Wave Theory | 3 |
| 613 | Engineering Aspects of Oceanography | 3 |
| 614 | Dynamics of the Ocean and Atmosphere | 3 |
| 615 | Long Waves and Tides | 4 |
| 616 | Theory of Ocean Waves | 3 |
| 617 | Theories of Ocean Circulation | 3 |
| 620 | Biological Oceanography | 3 |
| 622 | Analysis of Benthic Communities | 3 |
| 623 | Marine Zooplankton | 3 |
| 624 | Marine Phytoplankton | 3 |
| 630 | Geological Oceanography | 3 |
| 631 | Geological Oceanography | 3 |
| 632 | Lithophycology Oceanography | 3 |
| 633-34 | Carbonate Sediments | 2 |
| 635 | Techniques in Geological Oceanography | 4 |
| 638 | Simulation Techniques | 4 |
| 640 | Chemical Oceanography | 3 |
| 641 | Chemical Oceanography | 3 |
| 642 | Laboratory Techniques in Oceanography | 2 |
| 643 | Geochemistry of the Ocean | 3 |
| 644 | Isotope Geochemistry | 3 |
| 651 | Meteorological Oceanography | 3 |
| 652 | Ocean Boundary Layer Problems | 3 |
| 653 | Synoptic Physical Oceanography | 3 |
| 681 | Seminar I | 1 |
| 682 | Seminar II | 1 |
| 685 | Problems | 1 |
| 691 | Research (1 or more each semester) | 1-4 |

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Oceanography

Geyer, Richard A., Ph.D., Professor and Head of the Department of Oceanography
 Berner, Leo, Jr., Ph.D., Associate Professor of Biological Oceanography
 Bouma, Arnold H., Ph.D., Associate Professor of Geological Oceanography
 Bryant, William R., Ph.D., Associate Professor of Geological Oceanography
 Capurro, Luis R. A., D.Sc., Lecturer Physical Oceanography
 Caruthers, Jerald W., Ph.D., Assistant Professor of Physical Oceanography
 Clayton, William H., Ph.D., Professor of Physical Oceanography
 Cochrane, John D., M.S., Associate Professor of Physical Oceanography
 Darnell, Reznat M., Ph.D., Professor of Biological Oceanography
 El-Sayed, Sayed Z., Ph.D., Associate Professor of Biological Oceanography
 Ichiye, Takashi, D.Sc., Professor of Physical Oceanography
 Jeffrey, Lela M., M.S., Lecturer Chemical Oceanography
 Krishnamurty, Kotra V., Ph.D., Associate Professor of Chemical Oceanography
 Nowlin, Worth D., Jr., Ph.D., Associate Professor of Physical Oceanography

Department of Oceanography—Continued

Pequegnat, Willis E., Ph.D., Professor of Biological Oceanography

Ray, Sammy M., Ph.D., Associate Professor of Biological Oceanography and Director of the A&M Marine Laboratory

Reid, Robert O., M.S., Professor of Physical Oceanography

Rezak, Richard, Ph.D., Associate Professor of Geological Oceanography

Sackett, William M., Ph.D., Associate Professor of Chemical Oceanography

To obtain further information, address all inquiries directly to:

Dr. Richard A. Geyer

Head, Department of Oceanography

Texas A&M University

College Station, Texas 77843

TEXAS CHRISTIAN UNIVERSITY
Fort Worth, Texas

Most of marine science is carried out under the environmental sciences group of the TCU research foundation. Facilities include a 26-foot cruiser, equipped with depth recorder, winch, boom and a portable six-sensor water quality system with 24 channel multipoint recorder. Individual sensing equipment owned by the group consists of salinometer, oxygen meter, current strength and direction sensors and readout, pH meters, specific ion electrodes. Sampling equipment consists of a gravity corer, several bottom grabs, otter trawls, epibenthic trawl, dredges, plankton nets, scuba diving and underwater photographic equipment. Analytical equipment consists of atomic absorption spectrophotometer, X-ray fluorescence and diffraction units, gas chromatographs, various spectrophotometers, model E analytical ultracentrifuge, and an Hitachi H-8 electron microscope. Three laboratory areas have been set aside for marine-oriented research.

No specific degree in marine science is offered. M.S. degrees in Biology and Geology with emphasis on marine problems are offered.

The following courses are offered by the departments indicated in conjunction with the above programs:

Department of Biology

| | | | |
|------|--|--|---|
| 3104 | Invertebrate Zoology (once a year) | | 4 |
| 5713 | Marine Ecology (alternate years) | | 3 |
| 6103 | Invertebrate Morphology and Physiology (alternate years) | | 3 |
| 6323 | Principles of Paleoecology* (alternate years) | | 3 |
| 6503 | Fishery Biology (alternate years) | | 3 |
| 7000 | Special Topics in Marine Sciences (upon demand) | | 3 |
| 7900 | Thesis Research | | 6 |

Department of Geology

| | | | |
|------|--------------------------------|---------|---|
| 3123 | Descriptive Oceanography | Sp | 3 |
| 5243 | Geochemistry of Natural Waters | Alt. F | 3 |
| 5313 | Micropaleontology | Alt. Sp | 3 |
| 5513 | Sedimentation | Alt. F | 3 |

The instructional staff for the courses listed above consists of the following:

Department of Biology

Smith, J. Durward, Ph.D., Chairman and Assistant Professor of Biology
Blanton, William George, Ph.D., Adjunct Professor (from Texas Wesleyan College)
Couch, Ernest, Ph.D., Assistant Professor of Biology
Hewatt, Willis G., Ph.D., Professor of Biology
Keith, Donald E., Ph.D., Assistant Professor of Biology
Lyles, Sanders T., Ph.D., Professor of Biology
Newland, Leo G., Ph.D., Post-doctoral Fellow in sediment and water chemistry
Parker, Robert H., Doctoranden, dr. phil., Director, Environmental Sciences Group, Associate Professor of Biology

Department of Geology

Ehlmann, Arthur J., Ph.D., Chairman and Associate Professor of Geology
Heuer, Edward, M.S., Associate Professor of Geology
Slowey, J. Frank, Ph.D., Research Scientist, TCU Research Foundation, Assistant Professor of Geology
Steinmetz, Richard, Ph.D., Assistant Professor of Geology

To obtain further information, address all inquiries directly to:

Dean, Graduate School
Texas Christian University
Fort Worth, Texas 76129

*This course is also offered under the same number by the Department of Geology.

THE UNIVERSITY OF TEXAS MARINE SCIENCE INSTITUTE Port Aransas, Texas

The University offers courses in the marine sciences at both its main campus at Austin and its Marine Science Institute at Port Aransas, Texas. Research facilities on the 61-acre site of the Institute at Port Aransas include: 20,000 square feet of research, biological collection, library, and shop space. Most of this is air-conditioned. A laboratory with running seawater is located on a pier over the Aransas Pass inlet. There is a special air-conditioned vibration-free laboratory. Twenty concrete and fiberglass experimental ponds are located on the grounds. A variety of small boats, an air-boat and a 40-foot self-propelled barge are available, as well as the 44-foot LORENE, a trawler used in securing specimens. The Institute's boat basin is located adjacent to the laboratory buildings at the Aransas Pass ship channel.

Master of Arts and Doctor of Philosophy degree programs in the biological, physical, or earth sciences may be concentrated in the area of marine science. Marine science courses listed in the offerings of the various Main University science departments may be used as supporting work for programs in these or other science departments where they are pertinent.

1. M.A. in botany, chemistry, geology, microbiology, physics, zoology, or engineering with work concentrated in marine science.

Nine to 12 hours of marine science as the minor may be combined with 12 to 15 hours of the major and 6 hours of thesis registration for a total of 30 hours. There is no language requirement for the Masters degree in most of the related departments except Geology. The program of study and the thesis are approved by a supervisory committee appointed by the dean.

2. Ph.D. in botany, chemistry, geology, microbiology, physics, zoology, or engineering with work concentrated in marine science.

General Marine Science, Mn.S. 680, and the Principles of Marine Science, Mn.S. 382, are recommended as given in summers at Port Aransas along with courses in the major and supporting areas in Austin as designated by the supervising committee. Requirements and examinations for admission to candidacy vary according to the specifications of the Graduate Faculty of the Major Department in Austin as indicated in the Graduate Catalogue of the Main University. German, French or Russian is generally used to fulfill the language requirement of the Graduate School. A second language is part of the degree requirements of the major in most of the related science departments. There is no set number of course hours required. The program of study, languages, final oral exam and doctoral dissertation are approved by the supervisory committee and the Dean.

Courses in the marine sciences are offered during the regular long sessions at the Austin campus by the departments of Zoology, Geography, Civil Engineering, Meteorology, and Geology. The Marine Science Institute also offers regular summer courses and thesis research or special problems courses all year long at Port Aransas.

Courses Offered at Port Aransas

| | | |
|---------|--|---|
| 382.1 | Marine Invertebrates | 3 |
| 382.2* | Marine Microbiology | 3 |
| 382.3* | Marine Geology | 3 |
| 382.4 | Marine Botany | 3 |
| 382.52 | Marine Ichthyology | 3 |
| 382.53* | Ecology of Fishes | 3 |
| 382.6 | Marine Chemistry | 3 |
| 382.7* | Adaptive Mechanics in Marine Animals | 3 |
| 382.8* | Estuarine Ecology | 3 |
| 341† | General Marine Science | 3 |
| 481 | Biological Oceanography and Marine Ecology | 3 |
| 680 | Research in Marine Science | 6 |

*Offered Summer 1969 as 342. series for advanced undergraduates.

†Undergraduate course.

Courses Offered at Port Aransas—Continued

| | | |
|-------|--|---|
| 680.1 | Biological Oceanography, Marine Ecology, Limnology | 6 |
| 680.2 | Marine Microbiology | 6 |
| 680.3 | Marine Geology | 6 |
| 680.4 | Marine Botany | 6 |
| 680.5 | Marine Ichthyology | 6 |
| 682.6 | Marine Chemistry | 6 |
| 687 | Adaptive Mechanisms in Marine Animals | 6 |
| 688 | Estuarine Ecology | 6 |
| 690 | General Marine Science | 6 |
| 698 | Thesis | 6 |
| 699 | Dissertation | 6 |

Courses Offered at Austin Campus

(Excluding courses such as special problems, conference, dissertation, thesis, and seminar courses that may deal with marine sciences)

| | |
|-------|---|
| 241 | Environmental Health Engineering (Dept. of Civil Engineering) |
| 342 | Water Supply and Waste Water Disposal (Dept. of Civil Engineering) |
| 364 | Oceanography (Dept. of Geography) |
| 376 | Physical Oceanography (Dept. of Meteorology) |
| 391.2 | Marine Geology—Fall 1968 (To be given separate course number 1969-70) |
| 391.2 | Oceanography & Limnology—Spring 1968 (To be given separate course number) |
| 391.2 | Sedimentary Geochemistry—Spring 1968 (To be given separate course number) |
| 400 | Limnology and Oceanography (Dept. of Zoology) |

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Botany

Van Baalen, C., Ph.D., Associate Professor of Botany

Department of Chemistry

Parker, P. L., Ph.D., Assistant Professor of Chemistry

Department of Geology

Behrens, E. W., Ph.D., Assistant Professor of Geology

Department of Zoology

Wohlschlag, Donald E., Ph.D., Institute Director and Professor of Zoology

Copeland, B. J., Ph.D., Associate Professor of Zoology

Nicol, J. A. C., D.Sc., Professor of Zoology

To obtain further information, address all inquiries directly to:

Dr. Donald E. Wohlschlag, Director
The University of Texas
Marine Science Institute
Port Aransas, Texas 78373

UNITED STATES COAST GUARD ACADEMY New London, Connecticut

The Academy facilities include extensive physics and chemistry laboratories including a laboratory specially constructed for the study of biological and chemical oceanography. Hydrodynamics and structural mechanics instructional facilities include a 30-foot wave tank and generator. An array of small craft are maintained at the Academy and used by the Ocean Science Section for local field work during the academic year. Completely equipped sea going multipurpose oceanographic vessels, in excess of 300 feet long, are utilized during the summer semester. These vessels are used for training cadets in oceanographic sampling programs mainly in the Atlantic and Caribbean during a portion of the summer semester. An IBM 1620 Computer, located at the Academy, is used in most of the Ocean Science courses and research projects being carried out.

The Bachelor of Science (non-specified) is offered by the Academy. At the end of the sophomore year, after two years of pre-engineering subjects, cadets have the option of selecting a curriculum to follow in one of three major study areas: Social Science, Engineering Science, and Ocean Science. The Ocean Science curriculum is divided into two sub-major areas: Oceanography and Ocean Engineering. All Ocean Science cadets must take the following courses: 5321, 5323, 5326, and 5420. Those Ocean Science cadets electing to sub-major in Ocean Engineering must, in addition to following the Engineering Science curriculum, take 1490. Those Ocean Science cadets electing to sub-major in Oceanography must, in addition to the required Thermodynamics and Fluid Mechanics courses, take an additional three specified ocean science courses.

The following courses in Ocean Science are offered by the Physical Science Department, Ocean Science Section and the Applied Science and Engineering Department during the academic year. All summer at-sea programs, as well as all ocean research, are sponsored by the Physical Science Department.

| | | |
|------|---------------------------------------|-----|
| 5301 | Oceanography/Meteorology | 3.5 |
| 5321 | Physical Oceanography | 4 |
| 5323 | Biological/Chemical Oceanography | 4 |
| 5326 | Meteorology | 4 |
| 5420 | Waves and Tides | 3.5 |
| 5422 | Regional Oceanography | 4 |
| 5423 | Harbor Circulation and Pollution | 4 |
| 5424 | Air Sea Interaction | 4 |
| 5425 | Marine Biology/Geology | 4 |
| 5426 | Chemical Oceanography | 4 |
| 5427 | Marine Fisheries | 3 |
| 5428 | Observation Survey Techniques | 3 |
| 1490 | Ocean Engineering Design and Analysis | 3.5 |

The instructional staff for the courses listed above consists of the following:

Ocean Science Section, Department of Physical Science

Kollmeyer, Ronald C., CDR, USCG, M.S., Section Head and Associate Professor of Oceanography

McGill, David A., Ph.D., Professor of Oceanography

Nagel, Harold A., M.S., Assistant Professor of Oceanography/Meteorology

Costello, Hugh, MALS, Assistant Professor of Chemistry/Oceanography

Lissauer, Ivan A., B.S., Instructor of Oceanography/Meteorology

Ocean Engineering Section, Department of Applied Science and Engineering

White, Rodrick M., Nav.E. Sc.D., Section Head and Associate Professor Marine Engineering

To obtain further information, address all inquiries directly to:

Dean of Academics

U. S. Coast Guard Academy

New London, Connecticut 06320

**GRADUATE SCHOOL
U.S. DEPARTMENT OF AGRICULTURE
Washington, D. C.**

A Certified Statement of Accomplishment in Oceanography is granted to a student who has completed an organized program of courses in the field. The requirements for this Certified Statement are 20 semester hours of credit with a grade of C or better in each of the following courses:

- a. Required courses (6 credits):
 - Biological Oceanography (2)
 - Geological Oceanography (2)
 - Physical Properties of Sea Water (2)
- b. Electives (8 credits to be selected from the following group):
 - Applied Underwater Sound (2)
 - Biological Oceanography (4)
 - Chemical Oceanography (2)
 - Dynamic Oceanography (2)
 - Marine Geophysics (2)
 - Marine Meteorology (2)
 - Ocean Surface Waves (2)
 - Physics of Marine Atmosphere (2)
 - Practical Electronics for Biologists and Chemists (4)
 - Principles of Underwater Sound (2)
- c. 6 semester hours of credit in fields related to oceanography, including biology, chemistry, engineering, geography, geology, mathematics, and meteorology.

A student seeking this certified statement should consult with the Registrar and obtain approval of his proposed course of study early in his academic program. Equivalent courses will be accepted by transfer from other institutions. An applicant for this certified statement must file a transcript of his high school or college record before completion of his program.

The following courses are offered in conjunction with the school program:

| | | | |
|-------|----------------------------------|--------|---|
| 5-360 | General Oceanography | F, Su | 2 |
| 5-414 | Celestial Navigation | F, Sp | 3 |
| 5-475 | Principles of Underwater Sound | F | 2 |
| 5-476 | Applied Underwater Sound | Sp | 2 |
| 5-584 | Physical Properties of Sea Water | Sp | 2 |
| 5-655 | Ocean Surface Waves | Sp | 2 |
| 5-658 | Geological Oceanography | F | 3 |
| 5-546 | Physics of Marine Atmosphere | Sp | 2 |
| 5-520 | Marine Geophysics | F | 2 |
| 5-662 | Marine Meteorology | Alt. F | 2 |
| 5-664 | Dynarnic Oceanography | F | 2 |
| 5-666 | Biological Oceanography | F, Sp | 2 |

The instructional staff for the courses listed above consists of the following:

Ackerman, Karl H., Navigational Scientist, U.S. Naval Oceanographic Office
 Anderson, Rockne S., Oceanographer, U.S. Naval Oceanographic Office
 Burkhart, M. D., M.S., Oceanographer, U.S. Naval Oceanographic Office
 Cuzon Du Rest, Rene P., M.S., Oceanographer, National Oceanographic Data Center
 Gilcrest, Robert A., Physical Oceanographer, U.S. Naval Oceanographic Office
 Paulus, William C., Oceanographer-Instructor, U.S. Naval Oceanographic Office
 Peloquin, Robert A., Physical Oceanographer, U.S. Naval Oceanographic Office
 Picciolo, Anthony R., Ph.D., Head, Hydrobiology Branch, National Oceanographic Data Center
 Schule, J. J., Jr., B.A., Director, Oceanographic Prediction Division, U.S. Naval Oceanographic Office

Weiss Martin, Ph.D., Head, Geoscience Branch, National Oceanographic Data Center
Winokur, Robert S., B.S., Oceanographer, Acoustical Oceanography Branch, U.S. Naval Oceanographic Office

To obtain further information, address all inquiries directly to:

The Registrar

Graduate School

• U.S. Department of Agriculture
Washington, D. C. 20250

UNITED STATES NAVAL ACADEMY

Annapolis, Maryland

Facilities available include a recently completed environmental science laboratory with a semi-automatic weather station and an environmental data center. The laboratory is well equipped to support student research projects. A research vessel is available for use in the Oceanographic Applications course and for individual or group research. The 65-ton, 84-foot vessel has diesel-powered twin screws and is completely instrumented for data-collection and bathymetric surveying.

The Academy offers the B.S. degree with a major or minor specified in Oceanography. A core of required courses provides the student with a broad liberal education in mathematics, science, social science, and a thorough background in engineering, seamanship, navigation, and weaponry.

The following marine science courses are offered by the departments indicated:

Naval Science Department

| | | |
|-------|--|---|
| N-105 | Air-Ocean Environment | 3 |
| N-603 | Oceanography | 3 |
| N-607 | Meteorology | 3 |
| N-705 | Ocean Waves, Tides and Ice | 3 |
| N-708 | Synoptic Meteorology | 3 |
| N-821 | Nearshore Oceanography | 3 |
| N-832 | Oceanographic Applications | 4 |
| N-902 | Environmental Science Research Project | 3 |

Science Department

| | | |
|-------|-------------------------|---|
| S-609 | General Biology I | 3 |
| S-610 | General Biology II | 3 |
| S-611 | General Geology I | 3 |
| S-612 | General Geology II | 3 |
| S-720 | Chemical Oceanography | 3 |
| S-727 | Biological Oceanography | 3 |

The instructional staff for the courses listed above consists of the following:

Naval Science Department

Oceanography Committee

MacPherson, John J., Commander, USN, M.S., Committee Chairman
Hoffman, John, Ph.D., Associate Professor
Williams, Jerome, M.A., Associate Professor
Traganza, Eugene D., Ph.D., Associate Professor
Hendrix, Charles N. G., M.S., Associate Professor
Brookes, Allen G., LCDR, USN, M.S., Instructor
Schramm, William G., LCDR, USN, M.S., Instructor
Kelley, Robert D., LCDR, USN, M.S., Instructor
Tupaz, Jesus B., LT, USN, M.S., Instructor
Sharp, John B., LT, USN, B.S., Instructor
Smith, John A., LT, USN, M.S., Instructor

To obtain further information, address all inquiries directly to:

Dean of Admissions
U. S. Naval Academy
Annapolis, Maryland 21402

VIRGINIA INSTITUTE OF MARINE SCIENCE

Gloucester Point, Virginia

The Institute is located on the York River 30 miles from the mouth of Chesapeake Bay. A second campus at Wachapreague on seashore of Virginia's Eastern Shore provides access to the barrier beaches, lagoons, and marshes of the Atlantic Coast. Facilities include modern, permanent laboratory buildings, a research fleet with regular cruises over the continental shelf and a year-round research program.

All classwork and graduate study is directed by working scientists in the environment of an active marine research program. Modern laboratory and field instruments are available. An electron microscope has recently been added to the laboratory equipment inventory.

Research is being carried on in marine ecology, physiology of marine organisms, pollution problems, microbiology, radiobiology, diseases of shellfish, fish life histories, fishery biology, chemical oceanography, marine geology, meteorology, physical oceanography and parasitology.

The Institute offers the degrees of Master of Arts and Doctor of Philosophy in Marine Science through the School of Marine Science, College of William and Mary, Williamsburg, Virginia, and the degrees of Master of Arts and Doctor of Philosophy in Marine Science through the Department of Marine Science, University of Virginia, Charlottesville, Virginia, all with majors in Biological Oceanography, General Oceanography and Fishery Biology.

The following courses are offered in conjunction with the above program. These courses are also offered under different numbers by the Department of Marine Science, University of Virginia.

| | | |
|-----|---|--------------|
| 401 | Introduction to Physical Oceanography | 3 |
| 402 | Introduction to Chemical Oceanography | 3 |
| 403 | Introduction to Biological Oceanography | 3 |
| 404 | Introduction to Geological Oceanography | 3 |
| 405 | Problems in Marine Science | Maximum of 4 |
| 406 | Introduction to Marine Science | 5 |
| 407 | Biometry I | 4 |
| 410 | Marine and Freshwater Invertebrates | 5 |
| 412 | Marine Botany | 5 |
| 415 | Marine Botany—The Fungi | 5 |
| 501 | Marine Science Seminar | Maximum of 4 |
| 502 | Biological Oceanography | 5 |
| 503 | Advanced Problems in Marine Science | Maximum of 4 |
| 504 | Biology of Selected Marine Organisms | 5 |
| 505 | Radiobiology | 5 |
| 506 | Biology of Plankton | 5 |
| 507 | Marine Microbiology | 5 |
| 508 | Ichthyology | 5 |
| 509 | Physical Oceanography | 5 |
| 510 | Pollution Biology | 5 |
| 511 | Geological Oceanography | 3 |
| 512 | Parasites of Marine Organisms | 5 |
| 513 | Marine Biogeography | 3 |
| 514 | Littoral Processes | 4 |
| 515 | Embryology of Marine Invertebrates | 5 |
| 516 | Advanced Physical Oceanography | 3 |
| 517 | Behavior of Marine Organisms | 5 |
| 518 | Marine Fishery Science | 5 |
| 519 | Biometry II | 4 |
| 520 | Comparative Animal Physiology | 3 |
| 521 | Chemical Oceanography | 4 |

| | | |
|-----|--|--------------|
| 522 | Comparative Animal Physiology Laboratory | 2 |
| 523 | Topics in Applied Marine Science | Maximum of 4 |
| 560 | Thesis | |

The instructional staff for the courses listed above consists of the following:

Hargis, William Jennings Jr., Ph.D., Dean and Professor
 Andrews, Jay Donald, Ph.D., Professor
 Black, Robert E. Lee, Ph.D., Professor
 Brehmer, Morris Leroy, Ph.D., Professor
 Joseph, Edwin Bibb, Ph.D., Professor
 Van Engel, Willard Abraham, Ph.M., Professor
 Wood, John Langille, Ph.D., Professor
 Davis, William Jackson, Ph.D., Associate Professor
 Haven, Dexter Stearns, M.S., Associate Professor
 Nichols, Maynard M., Ph.D., Associate Professor
 Norcross, John Judson, M.S., Associate Professor
 Wass, Marvin Leroy, Ph.D., Associate Professor
 Wood, Langley Harris, Associate Professor
 Bailey, Robert Sydnor, M.S., Assistant Professor
 DuPuy, John L., Ph.D., Assistant
 Grant, George C., Ph.D., Assistant Professor
 MacIntyre, William Gordon, Ph.D., Assistant Professor
 Perkins, Frank Overton, Ph.D., Assistant Professor
 Ruzecki, Evon Paul, M.S., Assistant Professor
 Wang, Humphrey Yee-Chang, Ph.D., Assistant Professor
 Webb, Kenneth Louis, Ph.D., Assistant Professor
 Hyer, Paul V., B.S., Instructor
 Musick, John A., Ph.D., Instructor
 Owens, Dean Paul, M.S., Instructor
 Warinner, Junius Ernest III, M. A., Instructor
 Wojcik, Frank John, M.S. Instructor
 Zwerner, David Eric, M.A., Instructor

To obtain further information, address all inquiries directly to:

Dr. William J. Hargis, Jr.
 Director
 Virginia Institute of Marine Science
 Gloucester Point, Virginia 23062

WALLA WALLA COLLEGE
College Place, Washington

The college offers courses in marine biology at its marine station on Puget Sound. Facilities for the maintenance and use of marine organisms in research are also located in the new Life Sciences Complex on the main campus. Facilities at the Walla Walla College Marine Biological Station include four laboratory buildings which provide the following research laboratories: a general laboratory, a photoperiod laboratory for studies which must run under controlled environment conditions, a physiology research laboratory, three teaching laboratories, and a small general purpose laboratory. These are serviced by a circulating water system. In addition, the Marine Station operates a 40-foot research vessel and a smaller 26-foot cruiser which is available for research use. Also, a number of smaller boats are available.

The M.S. in biological sciences is offered by the college. All students must complete 45 graduate credits, pass departmental examinations, and carry out original research leading to a thesis.

Courses are offered by the Biology Department during the summer session at the Marine Station.

| | |
|-----|-------------------------|
| 427 | Coastal Flora |
| 429 | Limnology |
| 461 | Invertebrate Zoology |
| 462 | Ichthyology |
| 463 | Marine Botany |
| 467 | Biological Oceanography |
| 468 | Comparative Physiology |
| 524 | Marine Invertebrates |

The instructional staff for the courses listed above consists of the following:

Blake, Donald F., Ph.D., Acting Director

Forss, Carl A., Ph.D., Assistant Professor of Biology

Grable, Albert E., Ph.D., Assistant Professor of Biology

Rigby, Donald W., Ph.D., Professor of Biology and Head of Biology Department

To obtain further information, address all inquiries directly to:

Donald F. Blake

Acting Director

Marine Biological Station

Walla Walla College

College Place, Washington 99324

UNIVERSITY OF WASHINGTON
Seattle, Washington

DEPARTMENT OF OCEANOGRAPHY. The Department of Oceanography is located on the University campus on the shore of the Lake Washington Ship Canal. A new research building, and a new teaching building, have added to the facilities of the original building. Special facilities of the Department include a Development Laboratory with electronic mechanic shops, constant temperature rooms, a closed salt-water system, tidal models of Puget Sound and parts thereof, wave tanks and rotating models, and isotope ratio spectrophotometer, X-ray emission and gamma-ray spectrophotometers, a shipboard computer and a SCUBA support facility. Staging and dock facilities for research and training vessels of ocean-going size have recently been completed.

The Department has three research vessels, from 65 to 208 feet long, capable of cruising to any area of the world, which are berthed adjacent to the new research building. The use of various charter vessels is also available.

FRIDAY HARBOR LABORATORIES. The Friday Harbor Laboratories are located on a 484-acre tract on San Juan Island in the San Juan Archipelago of Washington State. Professors from various departments of the University (Botany, Fisheries, Atmospheric Sciences, Microbiology, Oceanography and Zoology) offer courses at a primarily graduate level with facilities also provided for independent researchers.

Representatives of all major and most minor phyla of invertebrates can be collected within a reasonable distance from the Laboratories. Shore collecting and dredging in many diverse ecological situations provide an abundance of forms for ecological, experimental, morphological and systematic work. A 55-foot power boat and fiberglass rowboats are available for sampling work. A cantilever pier is equipped for making various types of observations and is the location for the intakes of sea water systems for the laboratories. The teaching and research laboratories are housed in six one-story buildings and a new larger two-story building. Biological laboratories, photographic dark-rooms, walk-in cold rooms, microtechnique rooms and a shop are available. A 9,000 volume library is maintained on the Friday Harbor Campus by the University of Washington Library system. Housing and dining facilities are available for both single and family residences.

The following degrees are offered in the Department of Oceanography:

1. **Bachelor of Arts.** The student in the Bachelor of Arts curriculum must meet the requirements of the College of Arts and Sciences which include two years of language study (French, German or Russian recommended) and work in the fields of Humanities, Social Sciences and Natural Sciences. In addition, he must complete work in chemistry, geology, mathematics, physics and zoology. Required courses in Oceanography are Oceanography 203, 405 or 450, 401, 402 or 404J, 410, 412, 421-422, 423, 433 and 435 or 434 and 435.

2. **Bachelor of Science.** The Bachelor of Science curriculum is recommended for students contemplating graduate studies. The program requires approximately 35 credits in oceanography and the basic sciences beyond the curriculum for the Bachelor of Arts. French, German or Russian are the recommended languages. Before the end of the first two years the student should select one of four options. In addition to Oceanography 110-111-112, 443, 460 and 499 the options are in the fields of biological, chemical, geological and physical oceanography with course requirements determined by the area of interest.

3. **Master of Science.** The Department offers a thesis and a nonthesis program leading to the Master of Science degree. In both, the student and his adviser prepare a program of study to be approved by the student's Supervisory Committee. Proficiency in one foreign language, usually Russian, German, French or Japanese, must be demonstrated and Graduate School requirements for residence and course credits fulfilled. A qualifying written examination is required.

4. **Doctor of Philosophy.** The student and his Supervisory Committee prepare a program of study and research. A reading knowledge of two scientific languages, usually Russian, German, French or Japanese is required. The student must pass a General Examination in oceanography and supporting fields. He then completes the research for his dissertation and prepares for his Final Examination.

The Division of Marine Resources acts as coordinator of the work being carried out in the marine-related sciences between the many Departments and Colleges of the University which are active in this field. These include Atmospheric Sciences, Botany, Chemical Engineering, Civil Engineering, Economics, Fisheries, Food Science, Forestry, Geography, Geophysics, International Business, Law, Mechanical Engineering, Oceanography, and Zoology.

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

Atmospheric Sciences

| | | | |
|---------------|--|----------|-----------|
| 403J | Introduction to Geophysics: The Atmosphere | W | 5 |
| 431 | Atmospheric Physics | F | 5 |
| 462 | Sea-Air Transfer Processes | Su | 6 |
| 511J | Glaciology I: Formation of Snow and Ice Masses | W | 3 |
| 512J | Glaciology II: Structural Glaciology | Sp | 3 |
| 513J | Glaciology III: Dynamic Glaciology | F | 3 |
| 522 | Advanced Regional Climatology | W | |
| 528 | Applied Meteorology and Bioclimatology | Sp | 3 |
| 543, 544 | Planetary Fluid Dynamics | W | 3, 3 |
| 546, 547, 548 | Atmospheric Turbulence | F, W, Sp | 3, 3, 3 |
| 551 | Advanced Atmospheric Analysis | Sp | 5, max 10 |
| 560 | Theory of Meteorological Instrument | W | 3 |

Botany

| | | | |
|-----|---------------------------------------|--------|-----------|
| 445 | Marine Algology | Sp | 6 |
| 446 | Algology | Sp | 5 |
| 447 | Phytoplankton Morphology and Taxonomy | Alt. F | 4 |
| 448 | Marine Algal Ecology | Alt. W | 4 |
| 465 | Marine Mycology | Su | 6 |
| 475 | Problems in Algal Physiology | Su | 6 |
| 524 | Topics in Algology | W | 2, max 10 |

Geophysics

| | | | |
|-----|--------------------------|---|---|
| 415 | Principles of Glaciology | F | 4 |
| 572 | Tectonophysics | F | 3 |

Oceanography

| | | | |
|---------------|---|--------------|---------|
| 101 | Survey of Oceanography | F, W, Sp, Su | 5 |
| 109H | Survey of Oceanography—Honors | Sp | 5 |
| 110, 111, 112 | Lectures in Oceanography | F, W, Sp | 1, 1, 1 |
| 180H | Lower-Division Tutorial—Honors | Su | 6 |
| 203 | Introduction to Oceanography | Sp | 5 |
| 280H | Introduction to Oceanography—Honors | Sp | 5 |
| 360 | Methods and Instruments in Oceanography | Sp | 3 |
| 380H | Upper-Division Tutorial—Honors | Su | 6 |
| 385 | The Oceans I | Su | 10 |
| 386 | The Oceans II | Su | 10 |
| 401, 402 | General Physical Oceanography I, II | F, W | 5, 5 |
| 403 | General Biological Oceanography | W | 5 |
| 404 | Introduction to Geophysics: The Ocean | F | 5 |
| 405 | General Geological Oceanography | Sp | 5 |
| 406 | Introduction to Geological Oceanography | | 5 |
| 410 | Physical Oceanography | W | 3 |
| 411 | Ocean Tides and Waves | Sp | 3 |
| 412 | Ocean Currents | Sp | 3 |
| 415 | Fundamentals of Underwater Acoustics | F | 3 |
| 416 | Application of Underwater Acoustics | W | 2 |

Oceanography—Continued

| | | | |
|---------------|---|-------------------|-------------|
| 421, 422 | Chemical Oceanography | F, W | 2, 2 |
| 423, 424 | Chemical Oceanography Laboratory | F, W | 2, 2 |
| 433 | Biological Oceanography: Organisms and Processes | W | 3 |
| 434 | Biological Oceanography: Organisms and Environments | W | 3 |
| 435 | Biological Oceanography: Quantitative Aspects | Sp | 3 |
| 443 | Regional Oceanography | Sp | 2 |
| 444 | Design and Analysis of Oceanographic Experiments | | 3 |
| 450 | Geological Oceanography | Sp | 5 |
| 452 | Physical Sedimentology | | 3 |
| 454 | Biogenic Sediments I | F | 3 |
| 455 | Biogenic Sediments II | W | 3 |
| 456 | Acoustic and Seismic Techniques | W | 2 |
| 457 | Marine Sedimentation | | 3 |
| 460, 461 | Field Experience in Oceanography | F, W, Sp, Su | 1, 1–5 |
| 462 | Applications of Oceanography | W | 2, Max 6 |
| 480H | Undergraduate Research—Honors | F, W, Sp | 6 |
| 485 | Topics in Oceanography | | 2 |
| 488H | Field Experience—Honors | F, W, Sp | 2–6 |
| 489H | Undergraduate Thesis—Honors | F, W, Sp | 1–6 |
| 499 | Undergraduate Research | F, W, Sp | 1–3, Max 6 |
| 505 | Current Problems in Geological Oceanography | | 1 |
| 511, 512, 513 | Marine Hydrodynamics I, II, III | F, W, Sp | 4, 4, 4 |
| 514 | Seminar in Physical Oceanography | | 1, Max 9 |
| 515 | Waves | F (Odd Years) | 2 |
| 516 | Ocean Circulation | W (Even Years) | 2 |
| 517 | Oceanography of Inshore Waters | Sp (Odd Years) | 5 |
| 518 | Seminar in Dynamical Oceanography | F, W, Sp | Max 9 |
| 519 | Interaction of the Sea and Atmosphere | Sp | 5 |
| 520 | Seminar | F, W, Sp | 1, Max 9 |
| 521 | Seminar in Chemical Oceanography | F, W, Sp | Max 9 |
| 523 | Advanced Problems in Chemical Oceanography | F, W, Sp | 1–4, Max 18 |
| 530 | Marine Primary Productivity | Sp | 3 |
| 531 | Seminar in Biological Oceanography | F, W, Sp | Max 9 |
| 532 | Marine Microbiology | Sp | 1–4 |
| 533 | Zooplankton Ecology | Sp | 6 |
| 534 | Phytoplankton Ecology | Sp | 6 |
| 535 | Advanced Plankton Ecology | Sp | 2 |
| 536 | Benthos Ecology | Sp | 3 |
| 537 | Environmental Physiology of Marine Microalgae | F | 3 |
| 538 | Identification and Structure of Marine Benthic Communities | | 2 |
| 540 | Seminar in Geometrics | W | 1–3 |
| 544 | Statistical Models in Oceanography | W | 3 |
| 548 | Topics in Physical Oceanography | | 1–4, Max 9 |

Oceanography—Continued

| | | | |
|-------------------------------|---|--------------|--------|
| 550 | Seminar in Geological Oceanography | F, W, Sp | Max 9 |
| 551 | Marine Sediments | Sp | 3 |
| 553 | Research Techniques in Marine Geochemistry | | 2 |
| 554 | Research Techniques in Marine Geology | F | 3 |
| 555 | Marine Geochemistry | | 3 |
| 556 | Advanced Marine Geology | Sp | 3 |
| 560 | Fluid Mechanics of Erosion and Sediment Transport | W | 3 |
| 571 | Gravity and Geomagnetic Interpretation | | 3 |
| 573 | Terrestrial Magnetism | | 3 |
| 581 | Analysis of Sediments and Sedimentary Rocks | | 5 |
| 600 | Research | F, W, Sp, Su | Varied |
| 700 | Thesis | F, W, Sp, Su | Varied |
| 702 | Degree Final | F, W, Sp | 3 |
| Zoology | | | |
| 432 | Marine Invertebrate Zoology | Su | 8 |
| 472 | Principles of Ecology | W | 3 |
| 533 | Advanced Invertebrate Zoology | Su | 6 |
| 536 | Comparative Invertebrate Embryology | Su | 6 |
| 572 | Topics in Ecology | W | 2—3 |
| 574 | Ecology of Marine Communities | F | 3 |
| 578 | Advanced Ecology | F | 5 |
| International Business | | | |
| 420 | International Trade | W | 5 |
| Law | | | |
| 539 | Ocean Resources Seminar | F, W | 3 |
| 550 | Admiralty | F | 3 |
| 574 | Natural Resources | F | 3 |
| 587 | Natural Resources Seminar | W, Sp | 4 |
| Geography | | | |
| 370 | Conservation of Natural Resources | F, Sp | 5 |
| 444 | Geography of Water Resources | W | 3 or 5 |
| 477 | Urban Geography | F | 3 or 5 |
| 449 | Geography of Ocean Transportation | Sp | 3 or 5 |

The University also offers undergraduate and graduate programs in ocean engineering and fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Atmospheric Sciences:

Fleagle, R. G., Ph.D., Chairman and Professor of Theoretical and Dynamical Meteorology
 Badgley, F. I., Ph.D., Professor of Turbulence, Meteorological Instruments
 Buettner, K. J. K., Ph.D., Professor of Radiation, Bioclimatology
 Businger, J. A., Ph.D., Professor of Physical Meteorology, Turbulence
 Church, P. E., Ph. D., Professor Climatology.
 Holton, J. R., Ph.D., Assistant Professor of Fluid Dynamics
 Reed, R. J., Sc.D., Professor of Synoptic Meteorology, Numerical Prediction
 Untersteiner, N., Ph.D., Professor of Artic Heat Budget, Glaciology

Department of Botany

Norris, Richard Earl, Ph.D., Associate Professor of Algology
 Whisler, Howard Clinton, Ph.D., Associate Professor in Aquatic Fungi

Geophysics Group

Untersteiner, N. (see Atmospheric Sciences)
 Lister, Cliver R. N. (see Oceanography)

Department of Oceanography

Rattray, Maurice, Jr., Ph.D., Chairman and Professor of Physical Oceanography
Aagaard, Knut, Ph.D., Research Assistant Professor of Physical Oceanography
Anderson, George C., Ph.D., Research Associate Professor of Biological Oceanography and Limnology
Banse, Karl, Ph.D., Professor of Biological Oceanography
Barnes, Clifford A., Ph.D., Professor of Physical Oceanography
Bennett, Lee C., Ph.D., Assistant Professor of Geological Oceanography and Geophysics
Broenkow, William W., M.S., Acting Assistant Professor of Chemical Oceanography
Carpenter, Roy, Ph.D., Assistant Professor of Geochemical Oceanography
Coachman, Lawrence K., Ph.D., Associate Professor of Physical Oceanography
Creager, Joe S., Ph.D., Professor of Geological Oceanography
Dugdale, Richard C., Ph.D., Research Professor of Chemical and Biological Oceanography
Duxbury, Alyn C., Ph.D., Research Assistant Professor of Physical Oceanography
Echols, Ronald J., Ph.D., Research Assistant Professor of Geological Oceanography
English, T. Saunders, Ph.D., Associate Professor of Biological Oceanography
Fleming, Richard H., Ph.D., Professor of General Oceanography (Physical)
Kelley, James C., Ph.D., Assistant Professor of Geological Oceanography
Larsen, Lawrence H., Ph.D., Research Assistant Professor of Physical Oceanography
Lewin, Joyce C., Ph.D., Associate Professor of Biological Oceanography
Ling, Hsin-Yi, Ph.D., Research Assistant Professor of Geological Oceanography
Lister, Clive R. B., Ph.D., Research Assistant Professor of Geological Oceanography and Geophysics
McAlister, William B., Ph.D., Visiting Assistant Professor of Physical Oceanography
McManus, Dean A., Ph.D., Associate Professor of Geological Oceanography
Merrill, Ronald T., Ph.D., Assistant Professor of Geological Oceanography and Geophysics
Richards, Francis A., Ph.D., Professor of Chemical Oceanography
Smith, J. Dungan, Ph.D., Assistant Professor of Geological Oceanography and Geophysics
Sternberg, Richard W., Ph.D., Assistant Professor of Geological Oceanography
Taylor, Peter B., Ph.D., Assistant Professor of Biological Oceanography
Whetten, John T., Ph.D., Associate Professor of Geological Oceanography and Geology

Zoology:

Edmondson, Walles J., Ph.D., Professor of Zoology
Orians, Gordon H., Ph.D., Professor of Zoology

Geography Department:

Cooley, Richard A., Ph.D., Associate Professor of Resource Policies and Utilization
Marts, Marion E., Ph.D., Vice Provost; Director, Summer Quarter; Professor of Geography and Urban Planning
Ullman, Edward L., Ph.D., Professor of Urban and Transportation Geography
Fleming, D. K., Ph.D., Assistant Professor of Geography

International Business

Kolde, Endel, J., D.B.A., Professor of International Business and Marketing

School of Law

Johnson, Ralph W., LL.B., Professor of Law
Henderson, Don Fenno, Ph.D., Professor of Law

To obtain further information, address all inquiries directly to:

Dr. Stanley R. Murphy
Director, Division of Marine Resources
University of Washington
Seattle, Washington 98105

WESTERN WASHINGTON STATE COLLEGE
Bellingham, Washington

The marine sciences courses are offered in the departments of Biology and Geology which occupy separate floors of the Haggard Hall of Science. This building has facilities such as refrigerated salt water aquaria and several walk-in cold rooms for holding marine organisms. The two departments share machine shop and electronics shop facilities for the construction and maintenance of instruments. An electron microscope lab and a well equipped computer center are also available for use.

The Biology Department maintains a small marine research laboratory on Lummi Island which is about 45 minutes by car and ferry from the campus. Facilities at this site include large outside holding tanks supplied with running sea water and a small research laboratory which has been designed for the study of the effects of cycled environmental variables (salinity, temperature, and photoperiod) on marine organisms. A 20-foot open work skiff is available for light dredging and trawling operations in protected waters. The College has just purchased a 71 acre marine lab site near Anacortes for future development.

The B.A. and M.S. degrees in Biology and Geology with a concentration in marine science are offered by the college. At the B.A. level students take a core offering and may choose marine courses as part of the elective program. For the M.S., students are able to elect course work related to marine biology or geology and may undertake thesis work in marine science.

The following courses are offered in conjunction with the above programs:

Department of Biology

| | | |
|------|---|-----|
| 240 | Marine Biology | 3 |
| 300* | Special Projects in Biology | 1-2 |
| 301 | Ecology | 5 |
| 400* | Special Projects in Biology | 2-5 |
| 403 | Physiological Ecology of Marine Animals | 5 |
| 406 | General Oceanography | 3 |
| 500* | Special Projects in Biology | 2-5 |
| 501* | Thesis Research | 4-9 |
| 503* | Advanced Topics in Ecology | 4 |
| 504 | Ecological Instrumentation | 3 |
| 577* | Advanced Topics in Physiology | 4 |
| 583* | Advanced Topics in Biosystematics | 4 |
| 456 | Algae | 5 |
| 461 | Marine Invertebrate Zoology | 5 |

Department of Geology

| | | |
|-----|--|-----|
| 310 | Geomorphology | 5 |
| 316 | Paleontology | 5 |
| 340 | Geological Oceanography | 3 |
| 400 | Special Projects in Geology | 2-5 |
| 426 | Micropaleontology | 4 |
| 436 | Paleoecology | 4 |
| 446 | Clay Mineralogy | 4 |
| 507 | Coastal Geology | 4 |
| 516 | Problems in Biostratigraphy | 3 |
| 524 | Sedimentary Petrology and Geochemistry | 3 |
| 546 | Geology of Clays | 3 |

The instructional staff for the courses listed above consists of the following:

Department of Biology

Broad, A. Carter, Ph.D., Chairman and Professor of Biology
Dube, Maurice A., Ph.D., Associate Professor of Biology

*These courses may be offered with a marine emphasis.

Department of Biology—Continued

Heath, Wallace G., Ph.D., Associate Professor of Biology

Mason, David T., Ph.D., Assistant Professor of Biology

Ross, June P., Ph.D., Associate Professor of Biology

Schneider, David E., Ph.D., Assistant Professor of Biology

Department of Geology

Easterbrook, Don J., Ph.D., Professor of Geology and Chairman

Pevear, David R., Ph.D., Assistant Professor of Geology

Rahm, David A., Ph.D., Associate Professor of Geology

Ross, Charles A., Ph.D., Professor of Geology

Schwartz, Maurice L., Ph.D., Assistant Professor of Geology

Swineford, Ada, Ph.D., Associate Professor of Geology

To obtain further information, address all inquiries directly to:

Department of Biology: A. C. Broad, Chairman

Department of Biology

Western Washington State College

Bellingham, Washington 98225

Department of Geology: Don J. Easterbrook, Chairman

Department of Geology

Western Washington State College

Bellingham, Washington 98225

UNIVERSITY OF WISCONSIN
Madison, Wisconsin

In the past year, the marine sciences facilities at the University of Wisconsin have been substantially expanded. The newly completed Meteorology & Space Sciences building has one floor, about 5,500 square feet, devoted to physical oceanography. The administrative offices of the all-Campus Marine Studies Center are also located in this building. The Marine Research Laboratory, which is the natural science arm of the Marine Studies Center, is located in a separate building with 7,000 square feet of space. A new Engineering Research Building, to be completed in September, 1969, will have one floor devoted to ocean engineering.

In addition to these new laboratory facilities, the following facilities continue to be used for marine-related research and graduate training:

- Laboratory of Limnology—hydrobiology
- Engineering Hydraulics Laboratory—fluid mechanics and modelling
- Water Chemistry Laboratory—chemical oceanography
- Instrumentation Systems Center—instrumentation
- Geophysics Research Center—marine geophysics

The Oceanic Institute in Hawaii, through a working agreement with the University of Wisconsin, provides field and laboratory facilities for Wisconsin faculty and students. The Center for Great Lakes Studies at the University of Wisconsin-Milwaukee, with its diversified research facilities, is available to both staff and students. Extensive use is made of United States Coast Guard vessels on the Great Lakes.

Each laboratory facility is fully-equipped and the specialized equipment ranges from wave tanks and aquaria to numerous small boats up to 30 feet in length and fixed and barge-borne micrometeorological towers.

Supporting the above facilities is the University Computing Center. Available for use to all marine scientists are an IBM 1460, a CDC 3600, a CDC 1604, Univac 1108, plus appropriate software. The main library harbors more than one million volumes and there are specialized libraries for Earth Sciences (including Oceanography), Agriculture and Life Sciences, Biology, and Engineering.

The following degrees are offered in Marine Science:

1. **Ph.D. in Oceanography and Limnology; Minor in Oceanography and Limnology for Ph.D. in other fields.** The graduate training program in oceanography is administered by the Interdepartment Committee on Oceanography and Limnology. The program is based on the premise that oceanography and limnology should be considered together as an integrated field requiring a broad base in fundamental disciplines plus specialization in the application of one particular discipline to the hydrosphere. A student in the program will be required to have had mathematics through calculus and one year each in chemistry, and physics. In addition, the student will be required to take advanced work in marine and aquatic related subjects in two or more departments and will specialize in a particular aspect of oceanography and limnology, i.e., physical, chemical, geological, or biological. Study plans will be individually tailored for each student by a committee of three professors. At least one semester of marine experience is required. This is to be broadly interpreted to include research participation at a marine station, sea duty, duty on a floating ice island, systematic aerial measurements of marine phenomena or equivalent.

2. **College of Engineering offers a M.S. and Ph.D. with an option in Ocean Engineering.** Course programs are individually tailored for the students in a manner similar to that discussed above for the Oceanography and Limnology degree.

The following courses are offered in conjunction with the above programs:

Department of Botany

| | | | |
|-----|-----------------------------|----|---|
| 330 | Algae | Sp | 3 |
| 450 | Principles of Plant Ecology | Sp | 3 |

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|--|--|-----------------|--------|
| Department of Civil Engineering | | | |
| 406 | Remote Sensing of the Environment | F | 3 |
| 602 | Hydrodynamics | F | 3 |
| 612 | Open Channel Hydraulics | Sp | 3 |
| 621 | Hydrology | F, Sp | 3 |
| 622 | Water Resources Engineering | Sp | 3 |
| 661 | Ocean Dynamics | F | 4 |
| 66- | Ocean Environment | F | 3 |
| 66- | Technology of Ocean Operations | Sp | 3 |
| 669 | Ocean Engineering Seminar | Sp | 1-2 |
| 863 | Free Surface Flow II | Sp | 3 |
| 960 | Hydraulic Engineering and Fluid Mechanics Seminar | Sp | 1 |
| — | Diffusion and Dispersion | Sp | 3 |
| Department of Entomology | | | |
| 532 | Aquatic Insects | Sp | 3 |
| Department of Geology and Geophysics | | | |
| 130 | Survey of Oceanography | F, Sp | 3 |
| 525-526 | Micropaleontology | Alternate years | 3 |
| 533 | Geochemistry of Sediments | F | 3 |
| 535 | Physical Aspects of Sedimentation | Sp | 2 |
| 537 | Geological Oceanography | F | 3 |
| 538 | Recent Marine Sediments | Sp | 3 |
| 652 | Wave Propagation | F | 3 |
| 671 | Marine Geophysics | Alt. Sp | 3 |
| 777 | Sea Floor Geological Processes | F | 3 |
| 977 | Seminar in Sedimentation and Geological Oceanography | Sp | 2 |
| School of Law | | | |
| 845 | Water Rights Law | | 2 |
| 918 | International Law | | 2 |
| 919 | International Organizations | | 2 |
| 928 | Water Law | | 2 |
| Department of Meteorology | | | |
| 403 | Micrometeorology | Sp | 3 |
| 460 | Physical Oceanography | F | 3 |
| 461 | Physical Oceanography II | Sp | 3 |
| 501 | General Meteorology I | F | 5 |
| 502 | General Meteorology II | Sp | 5 |
| 551 | Geophysical Fluid Dynamics | Sp | 3 |
| 7— | Dynamic Oceanography I | | 3 |
| 7— | Dynamic Oceanography II | | 3 |
| 774 | Problems in Oceanography | Sp | 2 |
| 861 | Problems of Viscous Flow | F | 2 or 3 |
| 862 | Problems of Turbulent Flow | Sp | 2 or 3 |
| 960 | Seminar: Oceanography | Sem | 1 or 2 |
| Department of Political Science | | | |
| 504 | Science and Government | Sem | 3 |
| Department of Urban/Regional Planning | | | |
| 449 | Government and Natural Resources | Sem | 3 |
| 865 | Water Resources Institutions and Policies | Sp | 3 |
| 965 | Seminar in River Basin Planning | F | 2 or 3 |
| 966 | Seminar in Water Resources Planning | Sp | 2 or 3 |

Department of Water Chemistry

| | | | |
|-----|---------------------------------------|-------|---|
| 642 | Water Analysis | F | 3 |
| 644 | Water Chemistry | F | 3 |
| 645 | Water Analysis—Intermediate | F | 3 |
| 646 | Marine Chemistry | Sp | 2 |
| 770 | Advanced Water Chemistry | Sp | 3 |
| 771 | Advanced Techniques of Water Analysis | F | 3 |
| 772 | Advanced Techniques of Water Analysis | Sp | 3 |
| 773 | Organic Water Chemistry | F | 2 |
| 962 | Water Chemistry Seminar | F, Sp | 1 |

Department of Zoology

| | | | |
|-----|--|-------|--------|
| 300 | General Invertebrate Zoology | Sp | 3 |
| 500 | Ecology | F | 3 |
| 510 | Ecology of Fishes | Sp | 3 |
| 512 | Biology of the Plankton | Sp | 2 or 3 |
| 515 | Limnology—Conservation of Aquatic Resources | F | 2 |
| 615 | Biology of Aquatic Populations | F | 3 |
| — | Hydrobiology | F | 3 |
| 955 | Seminar: Limnology | F, Sp | 1 |

The instructional staff for the courses listed above consists of the following:

Department of Botany

Cottam, Grant, Ph.D., Professor of Botany
Gerloff, Gerald C., Ph.D., Professor of Botany
Loucks, Orie L., Ph.D., Professor of Botany

Department of Civil Engineering

Clapp, James L., Ph.D., Associate Professor of Civil Engineering
Green, Theodore (See Meteorology)
Hoopes, John A., Ph.D., Associate Professor of Civil Engineering
Huff, Dale D., Ph.D., Assistant Professor of Civil Engineering
Lenz, Arno T., Ph.D., Professor of Civil Engineering
Lettau, Heinz H. (See Meteorology)
Monkmeyer, Peter L., Ph.D., Associate Professor of Civil Engineering
Rohlich, Gerard A., Ph.D., Professor of Civil Engineering
Saul, William E., Ph.D., Associate Professor of Civil Engineering
Villemonte, James R., Ph.D., Professor of Civil Engineering

Department of Engineering Mechanics

Huang, T. C., Ph.D., Professor of Engineering Mechanics

Department of Entomology

Hilsenhoff, William L., Ph.D., Associate Professor of Entomology

Department of Geology and Geophysics

Clay, Clarence S., Ph.D., Professor of Geology and Geophysics
Clark, David L., Ph.D., Professor of Geology and Geophysics
Dott, Robert H., Ph.D., Professor of Geology and Geophysics
Meyer, Robert P., Ph.D., Professor of Geology and Geophysics
Moore, J. Robert, Ph.D., Professor of Geology and Geophysics
Steinhart, John, Ph.D., Professor of Geology and Geophysics

Department of Mechanical Engineering

Harker, Ralph J., M.S., Professor of Mechanical Engineering
Livermore, Donald F., Ph.D., Professor of Mechanical Engineering
Seirig, Ali A., Ph.D., Professor of Mechanical Engineering

Department of Meteorology

Bryson, Reid A., Ph.D., Professor of Meteorology
Csanady, Gabriel T., Ph.D., Professor of Meteorology
Green, Theodore, Ph.D., Associate Professor of Civil Engineering and Meteorology
Hastenrath, Stefan L., Ph.D., Associate Professor of Meteorology
Lettau, Heinz H., Ph.D. habil. Professor of Civil Engineering and Meteorology
Ragotzkie, Robert A., Ph.D., Professor of Meteorology
Stearns, Charles R., Ph.D., Assistant Professor of Meteorology
Young, John A., Ph.D., Assistant Professor of Meteorology

Department of Minerals and Metals

Heins, Robert W., Ph.D., Associate Professor of Mining Engineering

Department of Nuclear Engineering

Huston, Norman E., Ph.D., Professor of Nuclear Engineering

Department of Political Sciences

McCamy, James L., Ph.D., Professor of Political Science

Department of Urban/Regional Planning

Clarenbach, Fred A., Ph.D., Professor of Urban/Regional Planning
Fox, Irving K., M.A., Professor of Urban/Regional Planning

Department of Water Chemistry

Armstrong, David E., Ph.D., Assistant Professor of Water Chemistry
Lee, G. Fred, Ph.D., Professor of Water Chemistry

Department of Zoology

Fraser, Lemuel A., Ph.D., Professor of Zoology
Hasler, Arthur D., Ph.D., Professor of Zoology
Henderson, H. Francis, Ph.D., Assistant Professor of Zoology
Magnuson, John J., Ph.D., Associate Professor of Limnology

School of Law

Baldwin, Gordon B., Llb., Professor of Law
Bilder, Richard, Llb., Professor of Law
MacDonald, James B., J.D., Professor of Law
Runge, Carlisle P., J.D., Professor of Law

To obtain further information, address all inquiries directly to:

Professor Robert A. Ragotzkie
Chairman, Oceanography & Limnology Committee
University of Wisconsin
1225 West Dayton Street
Madison, Wisconsin 53706

WOODS HOLE OCEANOGRAPHIC INSTITUTION

Woods Hole, Massachusetts

The Institution has been conducting oceanographic research since its founding in 1930. Today, it operates one of the largest oceanographic research complexes in the country, maintaining water-front laboratory and docking facilities in Woods Hole on a year-around basis. Well equipped laboratories for research in biological, chemical, geological, geophysical and physical oceanography, and ocean engineering are currently in operation. These are backed up by available computer services through the Institution's own Information Processing Center and the combined library resources of the Institution, the Marine Biological Laboratory, and the Bureau of Commercial Fisheries Biological Laboratories, also located in Woods Hole. These extensive land-based facilities serve as the base of operation of the Institution's well-equipped, experienced oceanographic research fleet. **ATLANTIS II**, newest member of the fleet, was built in 1963 to the Institution's design specifically for oceanographic research. She is 210 feet long, has accommodations for a scientific party of 25 and four fixed laboratories, and carries such special features as anti-roll tanks, a bow thruster, and underwater observation ports. The **CHAIN**, 213-foot former Navy salvage ship, converted for oceanographic work in 1958, is also equipped for work on the high seas. **GOSNOLD**, a 99-foot ex-cargo vessel with portable laboratory units on deck, is outfitted for work on the continental shelf. **ASTERIAS**, a 40-foot coastal dragger, is equipped for inshore and estuarine work. A four-engine C54Q, converted for meteorological and airborne oceanic studies and a single-engine Helio-Courier useful for slow speed observation runs, are also operated by the Institution.

The following degrees are offered:

1. **Ph.D. and Sc.D.** offered jointly by M.I.T. and W.H.O.I.
2. **Ph.D. in Oceanography** offered by the Woods Hole Oceanographic Institution starting in 1969.

For the doctoral degree a student is required to pursue a program of advanced study leading to a general examination; to demonstrate ability in research by presentation and defense of a thesis; to meet language requirements (ability to read scientific literature in two acceptable foreign languages, or more extensive reading and speaking knowledge of one), and certain residence requirements.

To supply the breadth of outlook essential for the scientist concerned with the oceans as an interacting system, the Woods Hole Oceanographic Institution undertakes to provide, with courses, seminars, assigned readings and research in depth in special skills, the integrative outlook necessary for progress in the science of oceanography. Students entering the study of oceanography will be able to work in the environment created by mature research workers dedicated to solving problems of the seas without restraint of traditional special subject boundaries, but also under a rigorous intellectual regime which will necessitate the development of high competence in special selected areas.

Students working at the Institution must be capable of self-directed work. Major emphasis is placed on reading, experience in research, seminars and discussions. Relatively few courses are offered in a formal sense. Specialized and advanced basic course work may be undertaken as needed for proper intellectual development at recognized universities in the area by special arrangement.

The graduate study programs offered lead to the doctor's degree in oceanography awarded by the Institution or jointly with the Massachusetts Institute of Technology. The Institution also has an informal cooperative arrangement with Yale University, making possible cross-registration for courses and advanced study not available at Woods Hole. Similar arrangements with other institutions of higher learning may be exercised as needed.

While for administrative purposes the Institution is comprised of five departments, the education program centers around problems and individuals. The degree program is founded on the principle that oceanography is an interdisciplinary science, and therefore an interdisciplinary approach is virtually mandatory. Thus, individual scientists and engineers from all departments and disciplines represented at the Institution are involved in the program. A student does not enroll in any one department, but rather in the total program and is free to choose his area of specialization without restriction of departmental barriers.

To provide the broadly-based education in oceanography deemed necessary, the following five core courses are offered. Most other instruction is carried out in special seminars and through close

research supervision by individual staff members. Seminar offerings will depend largely on the interests of the students.

I. Marine Geology and Geophysics

This course will be taught in two parts. The first part will be an introduction to the geology of the sea floor. Concepts rather than details are stressed. Current ideas on the origin and history of the ocean basin and the continental margin will be emphasized. Discussion will also be devoted to beaches and the nearshore environments, and to the sediments and rocks of the ocean floor.

The second part will be primarily concerned with the physics of the earth. Emphasis will be placed on the solid earth, and the recent theories concerning the origin of continents and oceans.

Students should have had the equivalent of an undergraduate course in general geology or be prepared to undertake extra assigned study.

II. Chemical Oceanography

The course will stress wide coverage of the field emphasizing concepts rather than details. Topics to be covered include major ion composition, ionic species and equilibrium concepts, trace elements, the carbonate and silicate systems, dissolved gases, stable isotopes, radionuclides, and organic matter in the sea. The geochemistry of the sediments including the molecular interactions between clay minerals, carbonates and the dissolved and particulate organic matter will be reviewed. The course will integrate the marine geochemistry of the lithosphere, atmosphere and biosphere.

III. Biological Oceanography

The special adaptations of organisms for life in the sea and the impact of biological processes on the non-living components of the marine environment provide the core of the biological oceanography course. Among the ideas emphasized will be the cycling of energy and matter through the marine ecosystem, and the factors regulating the abundance, distribution, and community organization of marine microorganisms and metazoans. Through laboratory and shipboard work the student will be introduced to the marine environment and to the methods of studying the organisms and biological processes that occur in the sea.

IV. Physical Oceanography

The movement and physical structure of the ocean waters will form the core of the physical oceanography course. Topics to be covered will include a description of the general oceanic circulation and its dynamics, the interaction between the ocean and the atmosphere, and the physical properties of sea water. The subjects will be related to current research studies at W.H.O.I. Throughout, emphasis will be given to research methods: collecting, handling and analyzing oceanographic data, and the limitations of oceanographic tools.

A background in undergraduate physics and mathematics is a prerequisite.

V. Engineering Materials in the Ocean Environment

Many materials foreign to the ocean environment are introduced into it as aids to observation and measurement and to suit other needs of man. In addition, the sea itself can become an engineering material. This general course emphasizes the interaction of materials properties and the environment. It includes criteria for materials selection and the effects of this choice on observation and measurement of phenomena at their air-sea interface, within the sea, at the land-sea interface and beneath the sea floor. Applications include biology, chemistry, electrical and electronic components, hydromechanics including underwater acoustics, magnetics, optics, radiation, sealants, structure, thermodynamics, thermometry and high and low temperature.

This course is intended for those having interest in any branch of oceanography.

The instructional staff is drawn from the 150 members of the Scientific and Technical Staff of the Institution. A complete listing is given in the Institution's Annual Announcement, obtainable on request. In addition, ready access to the listed faculties of cooperating universities is available (see M.I.T. and Yale). Listed below are the W.H.O.I. department chairmen.

Department of Ocean Engineering

Daubin, Scott Crittenden, Ph.D., Senior Scientist

Department of Physical Oceanography

Fofonoff, Nicholas Paul, Ph.D., Senior Scientist

Department of Geology & Geophysics

Hays, Earl E., Ph.D., Senior Scientist

Department of Chemistry

Hunt, John M., Ph.D., Senior Scientist

Department of Biology

Ryther, John H., Ph.D., Senior Scientist

To obtain further information, address all inquiries directly to:

Dr. H. Burr Steinbach

Dean of Graduate Studies

Woods Hole Oceanographic Institution

Woods Hole, Massachusetts 02543

OTHER INSTITUTIONS OFFERING COURSES IN MARINE SCIENCE

**Gulf Coast Technical Institute, Mississippi State University
University of Houston**

CONSORTIA IN THE MARINE SCIENCES

GULF COAST RESEARCH LABORATORY
Ocean Springs, Mississippi

The Gulf Coast Research Laboratory offers summer courses in marine biology and marine geology as well as year round instruction and research programs leading to the M.S. and Ph.D. degrees in such areas as Biological Electron Microscopy, Morphology, Microbiology, Taxonomy, Biochemistry, Fisheries Biology, Marine Ecology, Bioenergetics and Aquatic Systems.

The Laboratory is a non-profit educational institution and is affiliated with the following colleges and universities:

Belhaven College
Delta State College
Millsaps College
Mississippi College
Mississippi State College for Women
Mississippi State University
University of Mississippi
University of Southern Mississippi
William Carey College
Auburn University
Bowling Green University
Jamestown College
Lambuth College

Louisiana State University
McNeese State College
Memphis State University
Northeast Louisiana State College
Northwestern State College of Louisiana
Northwest Missouri State College
Southwest Missouri State College
Southwestern Oklahoma State College
Tennessee Technological University
Tennessee Wesleyan College
Troy State College
Westmar College

For further information on any of the participating universities or colleges, please contact the university or college directly.

For further information on graduate research, please contact the Registrar, Gulf Coast Research Laboratory, Ocean Springs, Mississippi 39564.

164/165

GULF UNIVERSITIES RESEARCH CORPORATION
College Station, Texas

The Gulf Universities Research Corporation is a non-profit consortium of 17 universities and research institutes located near, and sharing interests in, the Gulf of Mexico and persons living on the periphery of the Gulf.

The aims of the Corporation are research, education, and public service, in pursuit of which the corporation will establish centralized research facilities in scientific areas of interest to its membership and in areas where the needs for supporting services and equipment are on such a large scale as to make single university ownership impractical or undesirable. Present interest of the corporation is in basic and applied research in marine science, including marine meteorology, physical oceanography, marine biology, marine geology, marine geophysics, pollution, remote sensing, and chemical oceanography.

The participating universities and research institutes are:

| | |
|---------------------------------------|------------------------------------|
| Florida State University | Tulane University |
| Louisiana State University | University of Alabama |
| Rice University | University of Florida |
| Southern Methodist University | University of Houston |
| Southwest Center for Advanced Studies | University of Miami |
| Southwest Research Institute | University of Southern Mississippi |
| Texas A&M University | University of Texas |
| Texas Christian University | University of Mexico |
| Texas Technological College | |

Corporation Headquarters are at 227 System Building, College Station, Texas 77843.

For further information on any of the participating universities or research institutes, please contact the university or institute directly.

MARINE SCIENCE CONSORTIUM OF PENNSYLVANIA COLLEGES AND UNIVERSITIES

Participating institutions:

Bloomsburg State College, Bloomsburg, Pa. 16912
 Community College of Philadelphia, Philadelphia, Pa. 19107
 Edinboro State College, Edinboro, Pa. 16412
 Indiana University of Pennsylvania, Indiana, Pa. 15701
 Kutztown State College, Kutztown, Pa. 19530
 Millersville State College, Millersville, Pa. 17551 (Administrative Center)
 Shippensburg State College, Shippensburg, Pa. 17257
 Slippery Rock State College, Slippery Rock, Pa. 16057
 West Chester State College, West Chester, Pa. 19380

Each of the participating institutions offers one or more courses in oceanography, for which classroom facilities, laboratory space, modest library support and access to computers are available on the various campuses.

In addition, the Consortium operates, through a non-profit corporation, the "Delaware Bay Marine Science Center," in Lewes, Delaware. This facility, a former U.S. Coast Guard Station, sleeps up to 40 students and faculty. Several classrooms, wet and dry laboratories, boat houses, workshops and garages as well as docking facilities for small vessels are part of the Center.

A 60 x 12-foot fully equipped, air-conditioned mobile laboratory is available. This trailer consists of a living locker, sedimentation lab, weighing and microscope room, drafting room, office and conference room.

Vessels include:

(1) a 34 x 15 foot research catamaran, with center well, traveling overhead gantry, hydro-winch, radar, loran-C, depth-recorder, and VHF radio. Propulsion is by twin inboard-outboard diesels (90 H.P. each), and the action radius is about 900 miles.

(2) a 38-foot converted Sportfisher, SANDPEBBLE, with davits and handwinches, depth-sounder and VHF radio, one 250 H.P. gasoline engine, single screw.

(3) a 30 foot converted lobster fisher, LYDIA B., with A-frame, handwinches, depth-sounder, diving platform and hookah-diving equipment, one 150 H.P. gasoline engine, single screw.

(4) two small boats are used for nearshore work.

A 12 passenger sportsman is available, through a grant by the Penn. Science and Engineering Foundation, for fieldtrips along the coast.

Presently no degrees in the Marine Sciences are offered. Undergraduate degrees consist of B.A. and B.S. in Education, Biology, Geology, Geography, Earth and Space Science, etc. At graduate level, the M.Ed. in Science is available.

In participating institutions with a divisional structure, marine science courses are restricted to the Division of Science. On the departmental level, oceanography courses are offered in the departments of geography, geology, geoscience and earth and space science (depending on the particular institution), and marine biology courses in the biology department.

All of the following courses are offered during the 3 week summer session at DBMSC. Those also offered at participating institutions during the year are so indicated.

Undergraduate Courses

| | | | |
|---------------|------------------------------------|----|---|
| Mar. Sci. 110 | Introductory Oceanography | Su | 3 |
| | Millersville State College | Sp | |
| | Indiana University of Pennsylvania | | |
| | Kutztown State College | | |
| | Slippery Rock State College | | |
| Mar. Sci. 211 | Field Methods in Nearshore and | | |
| | Estuarine Oceanography | Su | 3 |
| Mar. Sci. 221 | Invertebrate Zoology | Su | 3 |
| | Millersville State College | Sp | |
| | Kutztown State College | | |

Undergraduate Courses—Continued

| | | | |
|---------------|----------------------------|----|-----|
| Mar. Sci. 241 | Marine Biology | Su | 3 |
| Mar. Sci. 260 | Marine Ecology | Su | 3 |
| Mar. Sci. 331 | Chemical Oceanography | Su | 3 |
| | Millersville State College | F | |
| Mar. Sci. 362 | Marine Geology | Su | 3 |
| | Millersville State College | Sp | |
| Mar. Sci. 364 | Physical Oceanography | Su | 3 |
| Mar. Sci. 420 | Marine Micropaleontology | Su | 3 |
| Mar. Sci. 457 | Marine Geophysics | Su | 3 |
| Mar. Sci. 500 | Problems in Marine Science | Su | 3-6 |

Graduate Courses

For information about graduate courses, including N.S.F. summer institutes, contact the Marine Science Consortium.

The instructional staff for the courses listed above consists of the following:

Bloomsburg State College**Geology Department**

Lauffer, James, M.S., Assistant Professor, Geology

Community College of Philadelphia**Biology Department**

Schmidt, Eugene, M.S., Associate Professor, Physiology and Marine Biology

Edinboro State College**Geology Department**

Wegweiser, Arthur, Ph.D., Chairman, Department of Geology, Professor, Geology

Indiana University of Pennsylvania**Geoscience Department**

Prince, Paul A., M.A., Associate Professor, Oceanography and Meteorology

Biology Department

Liegey, Frank, Ph.D., Chairman, Department of Biology, Vice-President of Marine Science Consortium, Professor, Microbiology, Cell Physiology

Kutztown State College**Geography Department**

Mobley, Mary, M.S., Assistant Professor, Oceanography

Millersville State College**Biology Department**

McCormick, J. Michael, Ph.D., Assistant Professor, Marine Biology

Earth & Space Science Department

Davis, Donald R., Ph.D., Assistant Professor, Marine Chemistry, Water Pollution

Oostdam, Bernard L., M.S., President, Marine Science Consortium, Associate Professor, Oceanography, Marine Geology

Shippensburg State College**Geography Department**

Stratton, James F., M.A.T., Assistant Professor, Oceanography

Slippery Rock State College**Geology Department**

Bushnel, Kent, Ph.D., Associate Professor, Geophysics

Sutherland, Jeffery C., Ph.D., Associate Professor, Geology

Szucs, F. K., Sc.D., Chairman, Department of Geology, Professor, Geochemistry

West Chester State College**Biology Department**

Jones, Harry, M.S., Assistant Professor, Ecology

Chemistry Department

Greenberg, Seymour S., Ph.D., Professor, Geology

Admission to summer sessions requires:

- 1. Acceptance by the Admission Committee of the Consortium prior to April 15**

Inquiries to be directed to:

**Prof. B. L. Oostdam
Marine Science Consortium
Admission Committee
P. O. Box 43
Millersville, Pennsylvania 17551**

- 2. Admission to one of the participating institutions**

Contact the Admission Office or the Dean of Academic Affairs of the appropriate participating institution.

**Moss Landing Marine Laboratories
California State Colleges
Moss Landing (Monterey County), California**

Five California State Colleges (at Fresno, Hayward, Sacramento, San Francisco, and San Jose) jointly operate this seaside facility as a year-around center for upper division and graduate level education and research in the marine sciences. An average of 30 units of course work, plus Master's research and thesis, are provided every term (fall, spring, summer). The Laboratories face west on Monterey Bay at the point of origin of a deep submarine canyon. To the east, Moss Landing Harbor opens upon the diversified intertidal marsh and mudflat habitats of Elkhorn Slough. The buildings provide 14,000 square feet of classroom, research, laboratory, office, and library space, equipped to support the diversified curriculum and research needs of a multidisciplinary operation. A fleet of skiffs and small boats (8 to 24 feet) provide access to the nearshore marine and estuarine environments upon which the Laboratories focus primary instructional and research emphasis. Cooperative arrangements with governmental and privately owned vessels provide access to deeper waters. The Moss Landing Marine Laboratories began operation in 1966, and have expanded rapidly to near capacity (approximately 60 students, half graduate and half upper division undergraduate). Acquisition (1968) of five acres of adjacent land will permit further expansion of physical facilities as funding becomes available.

Since the Moss Landing Marine Laboratories are an integral part of five separate supporting colleges, degrees are earned through those colleges. Baccalaureate and Master's degrees in the basic sciences (e.g., Biology, Chemistry, Geology, Meteorology), may include concentrations in the marine field, to include one or more semesters of study at the Moss Landing Marine Laboratories. While details differ in the several institutions, the following general notes apply.

1. **B.A. or B.S. in Biology (or Botany, Conservation, Zoology for some Colleges).** Marine Sciences requirements at Moss Landing Marine Laboratories include General Oceanography, Marine Ecology, Marine Science Techniques, and Literature of the Marine Sciences, plus electives appropriate to the major interest. In the California State Colleges, a minimum of 124 units are required for the bachelor's degree, of which 45 must be in broad general education areas.

2. **B.A. or B.S. in Geology.** The marine sciences concentration will be similar to that for biology, with recommended electives including Marine Meteorology, Marine Biogenic Sediments, and General Oceanography.

3. **M.S. or M.S. in Biology, Geology, Meteorology, or Chemistry.** Thirty graduate units, to include six to ten units of required core courses, and research and thesis are required for the Master's degree. Some institutions also require reading competence in a foreign language. The Marine Sciences concentration usually includes a full year of work at the Moss Landing Marine Laboratories, with research and thesis on a marine environmental topic.

The Moss Landing Marine Laboratories curriculum supports two primary disciplines—marine biology and marine geology—for all five participating colleges. While labels differ at these colleges, majors served are in the baccalaureate and master's degree programs in biology and geology. Occasional course offerings also support majors in meteorology (San Jose State College), geography, and engineering. Special summer workshops and year-around seminar and special topics courses are designed for in-service marine sciences instruction of teachers at all levels.

The following courses are offered in conjunction with the above programs:

| | | | |
|-----|--------------------------------|-----------|---|
| 101 | General Oceanography | F, Sp, Su | 4 |
| 102 | Marine Science Techniques | F, Sp, Su | 1 |
| 111 | Zoology of Marine Vertebrates | F, Sp, Su | 4 |
| 115 | Marine Invertebrate Physiology | F | 4 |
| 121 | Marine Invertebrate Zoology | F, Sp, Su | 4 |
| 128 | Marine Invertebrate Embryology | Su* | 4 |
| 131 | Marine Algology | Sp, Su | 3 |

*Offered in alternate years.

| | | | |
|-----|---|-----------|-----|
| 133 | Micropaleontology | Sp* | 3 |
| 134 | Coastal Geomorphology | Su* | 3 |
| 135 | Marine Meteorology | F, Sp | 3 |
| 137 | Marine Biogenic Sediments | F | 3 |
| 141 | Geological Oceanography | Sp, Su | 4 |
| 160 | Ichthyology | Su | 4 |
| 161 | Marine Ecology | F, Sp, Su | 3 |
| 180 | Special Problems in the Marine Sciences | F, Sp, Su | 1-4 |
| 181 | Literature of the Marine Sciences | F, Sp, Su | 1 |
| 196 | Marine Science Diving | F, Sp, Su | 2 |
| 201 | Principles of the Marine Sciences | Sp | 3 |
| 255 | Ecology of the Gulf of California | Sp* | 4 |
| 260 | Seminar in Regional Geography | Sp* | 3 |
| 261 | Behavior of Marine Animals | Sp | 4 |
| 277 | Human Geography and Ecology of the Monterey Bay Area | F | 3 |
| 285 | Graduate Seminar | F, Sp, Su | 1 |
| 298 | Research in the Marine Sciences | F, Sp, Su | 1-4 |
| 299 | Master's Thesis | F, Sp, Su | 1-4 |

The instructional staff for the courses listed above consists of the following:

Harville, John P., Ph.D., Director, Moss Landing Marine Laboratories, and Professor of Biology, San Jose State College

Department of Biological Sciences

Bell, Charles W., Ph.D., Associate Professor of Biology, San Jose State College

Eickstaedt, Lawrence L., M.A., Assistant Professor of Biology, California State College, Hayward

Jensen, James B., M.A., Assistant Professor of Biology, California State College, Hayward

Meeker, Gary L., Ph.D., Assistant Professor of Biological Sciences, Sacramento State College

Morejohn, G. Victor, Ph.D., Professor of Biology, San Jose State College

Nybakken, James W., Ph.D., Associate Professor of Biological Sciences, California State College, Hayward

Tomlinson, Jack T., Ph.D., Professor of Biology, San Francisco State College

Yarberry, Edgar L., Ph.D., Assistant Professor of Biology, San Jose State College

Department of Geology

Arnal, Robert E., Ph.D., Professor of Geology and Oceanography, San Jose State College

Pestrong, Raymond, Ph.D., Assistant Professor of Geology, San Francisco State College

Stevens, Calvin H., Ph.D., Assistant Professor of Geology, San Jose State College

White, Stanton M., Ph.D., Assistant Professor of Geology, Fresno State College

Department of Meteorology

Read, Robert G., M.S., Associate Professor of Meteorology, San Jose State College

Department of Geography

Gordon, Burton L., Ph.D., Professor of Geography, San Francisco State College

Norsworthy, Stanley F., M.A., Assistant Professor of Geography, Fresno State College

To obtain further information, address all inquiries directly to:

John P. Harville, Director

Moss Landing Marine Laboratories

P. O. Box 223

Moss Landing, California 95039

*Offered in alternate years.

CURRICULA IN OCEAN ENGINEERING

172/173

UNIVERSITY OF ALASKA
College, Alaska

(For a description of the facilities and the marine science program at the University of Alaska, please refer to the University's listing in the Marine Sciences section of this publication.)

The University offers the M.S. degree in Ocean Engineering.

The program is coordinated by an interdisciplinary committee of the University composed of selected staff members from the academic colleges and research institutes involved with ocean science. At the M.S. level, the program emphasizes ocean-related course work in ocean engineering. However, additional graduate courses are recommended in the area of the student's undergraduate training to assure a high level of competence.

The minimum credit requirements for the M.S. degree are 30 graduate credits (9 of which may be thesis credits). One summer of approved field work may be substituted for a thesis. Course requirements—OCN 620, OCE 670, OCE 672, OCE 674, and OCE 680, and a minimum of six credits of additional course work to be selected by the student's committee.

The following courses are offered in conjunction with this program:

Electrical Engineering

| | | | |
|-----------|----------------------------------|----|------------------|
| E. E. 693 | Special Topics (Instrumentation) | F | Credits Arranged |
| E. E. 694 | Special Topics (Electronics) | Sp | Credits Arranged |

Engineering Management

| | | | |
|-----------|------------------------------|----|---|
| E. M. 605 | Advanced Engineering Economy | F | 3 |
| E. M. 611 | Engineering Management | F | 3 |
| E. M. 612 | Engineering Management | Sp | 3 |
| E. M. 613 | Engineering Management | Sp | 3 |

Civil Engineering

| | | | |
|-----------|--------------------------------|----|---|
| C. E. 603 | Arctic Engineering | F | 3 |
| C. E. 620 | Civil Engineering Construction | F | 3 |
| C. E. 631 | Advanced Structural Analysis | F | 3 |
| C. E. 632 | Advanced Structural Design | Sp | 3 |
| C. E. 644 | Hydraulic Engineering | Sp | 3 |
| OCE 670 | Waves and Tides | | 3 |
| OCE 672 | Underwater Acoustics | | 3 |
| OCN 674 | Environmental Hydrodynamics | | 3 |
| OCE 676 | Coastal Engineering | | 3 |
| OCE 680 | Ocean Engineering Field Work | | 3 |

The instructional staff for the courses listed above consists of the following:

Behlke, Charles E., Ph.D., Dean of College of Mathematics, Physical Sciences and Engineering;

Professor of Engineering

Goebel, Davis, Jr., Ph.D., Associate Professor of Electrical Engineering; Arctic Environmental Engineering Laboratory

Kinney, Patrick J., Ph.D., Assistant Professor of Marine Science; Chemical Engineering

Peyton, Harold R., Ph.D., Professor of Engineering; Arctic Environmental Engineering Laboratory

To obtain further information, address all inquiries directly to:

Dr. Donald W. Hood, Director
Institute of Marine Science
University of Alaska
College, Alaska

UNIVERSITY OF CALIFORNIA
Berkeley, California

Facilities for research within the University are located on the Berkeley campus and the nearby Richmond Field Station located on the shores of San Francisco Bay. Oceanographic research vessels are available in the bay area through working arrangements with the U. S. Geological Survey and the U. S. Bureau of Mines and in San Diego through the marine facilities of the Scripps Institution of Oceanography. The following is a partial listing of the facilities associated with the Berkeley campus:

Hydraulic Engineering Laboratory—deep wave channel; wind-wave tank, basin, and channel; wave and towing tank; model basins; sediment samplers; electronic analog-to-digital converter (HYDRA system).

Naval Architecture Laboratory—model towing tank; ship impact machine; ship structure test machine.

Sanitary Engineering Research Laboratory—treatment and reclamation of industrial and domestic wastes; apparatus for study of water pollution problems related to radioactive wastes, water resources, and air pollution.

Sea Water Conversion Laboratory—experimental unit for demineralizing sea water through solar distillation, electrodialysis, reverse osmosis, ion exchange methods.

Soil Mechanics Laboratory—strength testing with universal testing machine (4 million ton capacity); strain loading machine; triaxial compression cells; shaking table; earthquake loading machine; 8-channel oscillograph.

Structural Engineering Materials Laboratory—study behavior under load of structures and models using elastic displacement, strain measurement, moire-effect, and photo-elastic methods; control rooms provide wide range of temperature and humidity parameters.

Joint cooperation with the U. S. Bureau of Mines Marine Technology center, Tiburon, U. S. Corps of Engineers Bay Model, Sausalito, and U. S. Geological Survey Pacific Coast Marine Geology, Menlo Park round out extensive research facilities available to the Ocean Engineering student.

No one particular engineering discipline includes all the ramifications of Ocean Engineering. As a consequence, there is no Department of Ocean Engineering, and no degree in Ocean Engineering as such is granted. Ocean Engineering is a graduate option in several of the established departments in the College of Engineering. Students specializing in Ocean Engineering may obtain either a scientific or a professional degree, depending on the emphasis of the program they pursue. The degrees, Master of Science and Doctor of Philosophy in Engineering or Engineering Science, are granted upon completion of programs emphasizing theory, research, and design; the professional degrees, Master of Engineering and Doctor of Engineering, are granted upon completion of programs emphasizing economic and technical problems arising in the professional practice of engineering.

The Ocean Engineering Program within the College of Engineering includes the following departments: Civil Engineering, Materials Science and Engineering, Mechanical Engineering, and Naval Architecture. The Institute of Marine Resources sponsors research in inorganic marine resources, chiefly on the chemical and geological properties of ocean-bottom sediments in cooperation with the Ocean Engineering Program.

The Institute of Marine Resources also supports a research unit in Marine Food Science, within the administrative framework of the Department of Nutritional Sciences, College of Agricultural Sciences. Some teaching and seminars are conducted by institute personnel but no special courses are currently offered in this field. The research program involves the study of fundamental problems connected with the utilization of ocean fauna for food.

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

Department of Civil Engineering

| | | | |
|---------|-----------------------|----|---|
| CE 201A | Physical Oceanology | F | 3 |
| CE 201B | Chemical Oceanology | W | 3 |
| CE 201C | Geological Oceanology | Sp | 3 |

Department of Civil Engineering—Continued

| | | | |
|---------|--|----|---|
| CE 205A | Coastal Engineering | F | 3 |
| CE 205B | Coastal Engineering | W | 3 |
| CE 206A | River Hydraulics and Sedimentation | F | 3 |
| CE 206B | River Hydraulics and Sedimentation | W | 3 |
| CE 206C | River Hydraulics and Sedimentation | Sp | 3 |
| CE 207 | Advanced Hydraulic Design | Sp | 3 |
| CE 208 | Advanced Hydraulic-Structures Laboratory | Sp | 2 |
| CE 226 | Random Vibration of Structural Systems | F | 3 |
| CE 290J | Vibration of Ship Structures | F | 3 |

Department of Engineering

| | | | |
|-------|---------------------------|----------|---|
| E 298 | Ocean Engineering Seminar | F, W, Sp | 1 |
|-------|---------------------------|----------|---|

Department of Mechanical Engineering

| | | | |
|------------|--|--------------|-----|
| AS 262 | Theoretical Hydrodynamics | Sp | 4 |
| AS 263A, B | Viscous Fluid Flow | A—W, Sp, B—F | 4—4 |
| AS 290C | Turbulence | F | 4 |
| AS 298—5 | Geophysical Fluid Mechanics | | |
| AM 283 | Wave Propagation in Elastic Media | F | 4 |
| AM 290C | Acoustic Wave Propagation | Sp | 3 |
| AM 290E | Selected Topics in Wave Propagation in Anelastic Materials | W | 4 |
| ME 164 | Engineering Aero- and Hydro-Dynamics | Sp | 3 |
| ME 290N | Corrosion | W | 4 |

Department of Materials Science and Engineering

| | | | |
|---------|---|----|---|
| EG 106 | Applied Geophysics | Sp | 3 |
| EG 206 | Electrical, Magnetic, and Gravity Methods | W | 5 |
| EG 290A | Geophysical Measurements and Instruments | W | 3 |

Department of Naval Architecture

| | | | |
|---------------|---------------------------|----------------|---------|
| NA 240A, B, C | Theory of Ship Structures | A—F; B—W; C—Sp | 3, 3, 3 |
| NA 241A, B, C | Hydrodynamics of Ships | A—F; B—W; C—Sp | 3, 3, 3 |
| NA 242 | Advanced Ship Design | Sp | |

The instructional staff for the courses listed above consists of the following:

Department of Civil Engineering

Clough, R. W., Jr., Sc.D., Professor, Civil Engineering, Chairman of Division of Structural Engineering & Structural Mechanics
Duncan, J. M., Ph.D., Assistant Professor of Civil Engineering
Einstein, H. A., D.S.T., Professor of Hydraulic Engineering
Fischer, H. B., Ph.D., Assistant Professor of Hydraulic Engineering
Johnson, J. S., M.S., Professor of Hydraulic Engineering, Director of Hydraulic Engineering Laboratory
Lin, T. Y., M.S., Professor of Civil Engineering
Lysmer, J., Ph.D., Assistant Professor of Civil Engineering
McGauhey, P. H., M.S., Professor of Sanitary Engineering and Public Health, Director of Sanitary Engineering Research Laboratory
Mitchell, J. K., Sc.D., Associate Professor of Civil Engineering
Moffitt, F. H., M.C.E., Professor of Civil Engineering
Oswald, W. J., Ph.D., Professor of Sanitary Engineering
Pearson, E. A., Sc.D., Professor of Sanitary Engineering, Chairman, Division of Hydraulic and Sanitary Engineering
Penzien, J., Sc.D., Professor of Civil Engineering
Seed, H. B., Ph.D., Professor of Civil Engineering, Chairman, Department of Civil Engineering
Selleck, R. E., Ph.D., Associate Professor of Sanitary Engineering
Thomas, J. F., Ph.D., Professor of Sanitary Engineering

Department of Civil Engineering—Continued

Wiegel, R. L., M.S., Professor of Civil Engineering

Wilde, P., Ph.D., Assistant Professor of Hydraulic Engineering and Research Oceanographer,
Institute of Marine Resources

Witherspoon, P. A., Ph.D., Professor of Civil Engineering

Institute of Marine Resources—Nutritional Science (College of Agriculture)

W. D. Brown, Ph.D., Associate Professor of Marine Food Science

Olcott, H.S., Ph.D., Professor of Marine Food Science

Department of Materials Science and Engineering

Borgman, L. E., Ph.D., Associate Professor of Engineering Geoscience

Fuerstenau, D. W., Sc.D., Professor of Metallurgy

Morrison, H. F., Ph.D., Assistant Professor of Geophysical Engineering

Rodgers, P., Ph.D., Assistant Professor of Geophysical Engineering

Ward, S. H., Ph.D., Professor of Geophysical Engineering

Department of Mechanical Engineering

Corcos, G. M., Ph.D., Professor of Aeronautical Sciences

Cornet, I., Ph.D., Professor of Mechanical Engineering

Holt, M., Ph.D., Professor of Aeronautical Sciences

Howe, E. D., M.S., Professor of Mechanical Engineering

Laird, A. D. K., Ph.D., Professor of Mechanical Engineering, Director of Sea Water Conversion Laboratory

Schaaf, S. A., Ph.D., Professor of Engineering Science

Sherman, F. S., Ph.D., Professor of Aeronautical Sciences

Department of Naval Architecture

Paulling, J. R., Jr., D. Eng., Associate Professor of Naval Architecture, Chairman, Department of Naval Architecture

Schade, H. A., Dr. Ing., Professor of Naval Architecture, Emeritus

Sibul, O. J., M.S., Lecturer in Naval Architecture

Wehausen, J. V., Ph.D., Professor of Engineering Science

To obtain further information, address all inquiries directly to:

A. Ocean Engineering

Professor P. Wilde, Chairman

Committee on Engineering in the Ocean Environment

College of Engineering

University of California

Berkeley, California 94720

B. Marine Food Sciences

Professor H. S. Olcott

I.M.R. Department of Nutritional Sciences

University of California

Morgan Hall

Berkeley, California 94720

THE CATHOLIC UNIVERSITY OF AMERICA

Washington, D. C.

The university offers undergraduate and graduate programs at its main campus in northeast Washington. The Institute of Ocean Science and Engineering was established at the university in 1967 to foster research and academic programs in the marine sciences. The major areas of marine related research are: underwater acoustics, properties of transducers, structure and physical properties of salt water, marine cables, instrumentation, signal processing, and fluid dynamics. Research facilities include: four tanks for underwater acoustics; one tank for underwater optics; instrumentation, fluid dynamics, soil mechanics, and physical properties of water laboratories. The university has participated in a cooperative program with three local Naval Laboratories since 1967. This program sponsors mutual use of research facilities and oceanographic ships. Computer facilities include two IBM 1130 computers (one has had extensive at-sea use on the U.S.N.S. KANE), one IBM 1620, and shared time facilities. The university is also a member of the Washington Consortium of Universities.

The following degrees are offered in ocean engineering and related fields:

1. D. Engr. or Ph.D. in Ocean Engineering (Department of Mechanical Engineering). Candidates for the Doctorate in Ocean Engineering must satisfactorily complete two years of full-time resident graduate study beyond the Master's degree, or its equivalent on a part-time or three-quarter time basis. Degree requirements may be summarized as follows: a major course program (a minimum of thirty-five credit hours beyond the Bachelor's degree), eighteen credit hours in a minor field (usually mathematics) or twelve credit hours in a first minor field and six credit hours in a second minor field, written comprehensive examinations in the major and first minor fields, a reading knowledge of two foreign languages, a dissertation, and an oral defense of dissertation. Doctoral programs in Ocean Engineering are tailored to meet the needs of the individual student. Candidates may specialize in Fluid or Solid Mechanics, Heat Transfer or Thermodynamics, Control System, Underwater Acoustics or Civil Engineering. All doctoral candidates in Ocean Engineering must take a minimum of nine credit hours in pure or applied oceanography, six one semester upper level graduate courses in their specialty area, and acquire appropriate at-sea experience.

2. M.S.E. in Ocean Engineering or in Ocean Engineering (Acoustics) (Department of Mechanical Engineering). Candidates for the degree of Master of Science in Ocean Engineering are required to satisfactorily complete one year of full-time graduate study (approximately thirty (30) credit hours including research and seminars), or its equivalent on a part-time or three-quarter time basis. A comprehensive examination in the major field plus a thesis is required. There are no foreign language requirements for the M.S.E. degree. A typical Master's program in Ocean Engineering would consist of ME 533, ME 507, CEM 541, ME 502 and one elective in pure or applied oceanography. In addition all candidates must minor in mathematics. A typical program for Ocean Engineers specializing in underwater acoustics consists of ME 507, CEM 541, CEM 562, CEM 563, an elective course in acoustics, and one in pure or applied oceanography. The minor requirements are as stated above.

3. D. Engr. or Ph.D. in Engineering Acoustics (Department of Civil Engineering and Mechanics). Candidates for the Doctorate in Engineering Acoustics must satisfactorily complete two years of full-time resident graduate study beyond the Master's degree, or its equivalent on a part-time or three-quarter time basis. Degree requirements may be summarized as follows: a major course program (a minimum of thirty-five credit hours beyond the Bachelor's degree), eighteen credit hours in a minor field (usually mathematics) or twelve credit hours in a first minor field and six credit hours in a second minor field, written comprehensive examinations in the major and first minor fields, a reading knowledge of two foreign languages, a dissertation, and an oral defense of the dissertation. Doctoral programs in Engineering Acoustics are tailored to meet the needs of the individual students who may specialize in either underwater, theoretical, statistical, or physical acoustics. However, the following courses are required of all doctoral candidates: CEM 532, CEM 761 and 762, and CEM 741.

4. M.S.E. in Engineering Acoustics (Department of Civil Engineering and Mechanics). Candidates for the degree of Master of Science in Engineering (Acoustics) are required to satisfactorily

complete one year of full-time graduate study (approximately thirty (30) credit hours including research and seminars), or its equivalent on a part-time or three-quarter time basis. A comprehensive examination in the major field plus a thesis is required. There are no foreign language requirements for the M.S.E. degree. A typical Master's program in Engineering Acoustics would consist of CEM 501, CEM 541, CEM 562, CEM 568, and two electives in the major field. In addition, all candidates must minor in mathematics.

5. M.S.E. in Water Resources Engineering (Department of Civil Engineering and Mechanics). Candidates for the degree of Master of Science in Engineering (Water Resources Engineering) are required to satisfactorily complete one year of full-time graduate study (approximately thirty (30) credit hours including research and seminars), or its equivalent on a part-time or three-quarter-time basis. A comprehensive examination in the major field plus a thesis is required. There are no foreign language requirements for the M.S.E. degree. A typical Master's program in Water Resources Engineering would consist of CEM 581, CEM 582, CEM 584, CEM 782, and two electives in the major field and six (6) credit hours in an appropriate minor field.

6. B.S.M.E. (Ocean Engineering Option) (Department of Mechanical Engineering). (This degree will be offered for the first time in 1969-70.) Undergraduate students in this program follow the same curriculum as other mechanical engineering students during the freshman and sophomore years. Required Ocean Engineering courses in the junior and senior year are ME 342, ME 344, and ME 401. The other required courses follow the M.E. curriculum. Projects related to Ocean Engineering are included in the laboratory and design courses. Fifteen semester hours of electives in the senior year may be selected from an extensive list of mechanical and ocean engineering courses at the senior and the beginning graduate level.

The following courses are offered in conjunction with the above programs:

Mechanical Engineering Department

| | | |
|----------|--|------|
| 502 | Structural Mechanics | 3 |
| 505, 506 | Design of Mechanical Systems | 2, 2 |
| 507 | Physical Oceanography | 3 |
| 508 | Ocean Waves | 3 |
| 514 | Geological Oceanography | 3 |
| 516 | Instrumentation | 3 |
| 533 | Mechanics of Continua | 3 |
| 535 | Advanced Fluid Dynamics | 3 |
| 575, 576 | General Geophysics and Space Physics | 2, 2 |
| 578 | Desalination | 2 |
| 597, 598 | Mechanical Engineering Seminar | 1, 1 |
| 701, 702 | Advanced Design and Analysis of Mechanical Systems | 2, 2 |
| 731, 732 | Theoretical Hydrodynamics | 3, 3 |
| 735, 736 | Geophysical Fluid Mechanics | 3, 3 |
| 747, 748 | Physics of Fluids | 3, 3 |

Civil Engineering and Mechanical Department

| | | |
|----------|--|------|
| 531, 532 | Experimental Dynamics | 3, 3 |
| 541 | Advanced Dynamics | 3 |
| 562 | Theory of Waves | 3 |
| 563 | Principles of Underwater Sound | 2 |
| 564 | Underwater Sound Propagation | 2 |
| 568 | Electromechanical Circuits and Transducers | 2 |
| 741, 742 | Vibrations of Elastic Solids | 3 |
| 744 | Nonlinear Vibrations | 3 |
| 761, 762 | Theoretical Acoustics | 3 |
| 772 | Physical Acoustics | 3 |
| 763, 764 | Special Topics in Advanced Acoustics | 2, 2 |
| 525 | Waterways and Harbor Engineering | 3 |
| 581 | Hydrology | 3 |

Civil Engineering and Mechanics Department—Continued

| | | |
|----------|--|------|
| 582 | Hydraulics of Open Channels | 3 |
| 583 | Water Resources Engineering Economics | 3 |
| 584 | Water Supply and Pollution Control Engineering | 3 |
| 585, 586 | Water Resources Planning | 3, 3 |
| 587 | Current Problems in Water Resources | 3 |
| 588 | Public Water Policies and Organizations | 3 |
| 682 | Objectives and Applications of Water Resources Development | 3 |
| 725 | Waterways and Dam Engineering | 3 |
| 782 | Water Resources Systems Analysis | 3 |
| 783, 784 | Water Quality Management | 3 |
| 788 | Planning for Hydroelectric Power Development | 3 |

Odd-numbered courses are offered in the Fall Semester and even-numbered courses in the Spring.
The instructional staff for the courses listed above consists of the following:

Department of Mechanical Engineering

Andrews, Frank A., Ph.D., Chairman and Professor of Acoustics
Blomquist, Donald S., M.S., Assistant Professor in Mechanical Engineering-Instrumentation
Casarella, Mario J., Ph.D., Associate Professor of Fluid Mechanics
Curran, Henry M., Ph.D., Associate Professor of Mechanical Engineering
Gilheany, John J., Ph.D., Associate Professor of Ocean Engineering
Heller, S. R., Jr., Sc.D., Professor of Ocean Engineering
Jackson, Francis J., Ph.D., Adjunct Professor of Acoustics
Laura, Patricio A., Ph.D., Associate Professor of Mechanical Engineering
Schneider, Erick, M.S., Lecturer in Oceanography
Schule, John J., B.A., Lecturer in Oceanography

Department of Civil Engineering and Mechanics

Baltrukonis, John H., M.C.E., Chairman and Professor of Mechanics
Dea, Stanley, Ph.D., Lecturer in Water Resources
Greenspan, Martin, B.S., Adjunct Professor of Acoustics
Hanish, Samuel, M.S., Lecturer
Hudimac, Albert A., Ph.D., Associate Professor of Acoustics
Macedo, Pedro B., Ph.D., Associate Professor of Acoustics
Magrab, Edward B., Ph.D., Associate Professor of Mechanics
Martin, Edward, Ph.D., Lecturer in Water Resources
McDaniel, William, M.A., Associate Professor of Planning
Pappas, Dean, M.S.E., Lecturer in Water Resources
Parsons, Donald, M.S.C.E., Lecturer in Hydrology
Urlick, Robert, M.S., Lecturer in Acoustics
Witzig, Bernard, C.E., Lecturer in Water Resources
Young, G. Kenneth, Ph.D., Lecturer in Water Resources

To obtain further information, address all inquiries directly to:

Dr. John J. Gilheany
Institute of Ocean Science and Engineering
Catholic University of America
Washington, D. C.

UNIVERSITY OF DELAWARE
Newark, Delaware

Ocean Engineering courses are offered both at the main campus in Newark and the Marine Laboratory's field station at Lewes, Delaware. On campus laboratory facilities are located primarily within the departments of Civil and Mechanical and Aerospace Engineering. The fluid mechanics laboratory contains a free surface hydrodynamic tank with flows to 4000 gpm., a subsonic wind tunnel (140 fps), a ripple-tow tank with 4 ft. x 6 ft. test section, a 120 ft. long x 5 ft. x 8 ft. flume, a rotating flow table and a small wave tank. High speed cameras and hydrogen bubble generators used for flow visualization are among the specialized equipment available.

The environmental engineering laboratories are equipped for chemical and biological analysis of water. Specialized equipment includes stability indicator, turbidimeter, BOD apparatus, Kjeldahl N apparatus, spectrophotometer, polarograph, rotary viscometer, Warburg respirator, and a D.O. probe accurate to one part per billion of dissolved oxygen.

Well equipped soil mechanics, metallurgical, and structural laboratories are also available for marine-oriented research. Field research and instruction in coastal and oceanographic engineering are conducted at the Lewes field station using classrooms, laboratories, and vessels located there.

The University offers the following degrees:

1. **Bachelor of Civil Engineering—Specialization in Ocean Engineering** (Department of Civil Engineering). All students are required to complete the basic civil engineering curriculum requiring (130) semester hours of course credit. This includes (112) hours of required course work and allows (18) hours of technical electives which may be devoted to marine-related courses or special projects. Similar B.S. degree programs in Chemical Engineering, Electrical Engineering and Mechanical and Aerospace Engineering.

2. **Master of Applied Science in Ocean Engineering.** This program requires that a student complete (30) credit hours of graduate study beyond the bachelor's degree of which (24) are in course work plus (6) hours of thesis. Considerable flexibility is available to permit a student to formulate a program suited to his specific interests.

3. **Ph.D. of Applied Science in Ocean Engineering.** Essentially 72 semester credits beyond the bachelor's degree are required including approximately (24) credits in the areas of mathematics, physical and engineering science, and (24) credits in thesis research. A broad range of programs can be arranged to fit the student's particular research interests.

Ocean engineering is an interdisciplinary program sponsored on an interdepartmental basis by the College of Engineering. At present most marine-related courses are offered by the Department of Civil Engineering but with other departments (i.e., Chemical, Electrical, and Mechanical and Aerospace) prepared to assist students in formulating programs in their area of specialization, and to provide appropriate special problem studies.

The courses specifically related to an ocean engineering program are listed below. Other courses not listed, but available to complete an ocean engineering program, are offered in the areas of oceanography, marine biology, mathematics, statistics, operations research, structural engineering, water resources engineering, fluid mechanics, hydraulics, electrical engineering, transportation engineering, soil mechanics, mechanical engineering, metallurgy and materials engineering.

| | | | |
|--------|--------------------------------------|-------|-----|
| CE 665 | Ocean Engineering Seminar | F, Sp | 1 |
| CE 666 | Engineering in a Coastal Environment | Su | 3 |
| CE 671 | Ocean Engineering I | F | 3 |
| CE 672 | Ocean Engineering II | Sp | 3 |
| CE 837 | Mechanics of Free Surface Flow | F* | 3 |
| CE 839 | Applied Hydraulics | Sp* | 3 |
| CE 866 | Special Problems | | 1-6 |
| CE 871 | Marine Structures I (Floating) | F | 3 |
| CE 872 | Marine Structures II (Fixed) | Sp | 3 |

*Offered in alternate years.

| | | | |
|---------|--|----|---|
| CE 873* | Marine Transportation Systems | Sp | 3 |
| CE 874* | Geophysical Fluid Mechanics | | 3 |
| G 220 | Meteorology | Sp | 3 |
| GEO 631 | Marine Geology | | 3 |
| GEO 637 | Geology of Recent Sedimentary Environments | | 3 |
| MAE 622 | Introduction to Stability and Control | | 3 |
| MAE 633 | Hydromechanics | | 3 |
| MAE 833 | Fluid Mechanic Stability | | 3 |
| MET 611 | Corrosion and Corrosion Control | Sp | 3 |

The University also offers undergraduate and graduate programs in marine sciences which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Civil Engineering

Boyer, Don L., Ph.D., Assistant Professor of Civil and Mechanical and Aerospace Engineering

Gaither, William S., Ph.D., Associate Professor of Civil Engineering and Ocean Engineering

Program Coordinator

Jordaan, Jan M., Sc.D., Associate Professor of Civil Engineering

Department of Mechanical and Aerospace Engineering

Seidel, Barry S., Sc.D., Associate Professor of Mechanical and Aerospace Engineering

To obtain further information, address all inquiries directly to:

Dr. W. S. Gaither
College of Engineering
University of Delaware
Newark, Delaware 19711

*Available upon sufficient student demand.

FLORIDA ATLANTIC UNIVERSITY Boca Raton, Florida

Florida Atlantic University offers ocean engineering and marine science courses at its main campus in Boca Raton, Florida. Florida Atlantic University is an upper division university (junior and senior years plus graduate work) which includes a College of Science and a separate Department of Ocean Engineering. It is a part of the State of Florida University system. Students entering FAU must have successfully completed two years at a junior college or the equivalent at a four year institution and meet the prerequisites of the department they desire to enter.

The Department of Ocean Engineering has laboratories for Electrical, Mechanical and Materials Engineering; Fluids and Acoustics instruction. Small boats are available for ocean engineering instruction and work at sea. Large vessels, when needed, will be chartered or obtained through the Florida Institute of Oceanography.

A Cooperative Work-Study program is available for students who maintain a 2.5 (out of 4.0) average which enables them to spend alternating 6 month periods on campus and on-the-job with participating ocean engineering companies and government laboratories. Students can enter the Cooperative program in September or March of each calendar year.

The University offers the degree of B.S. in Engineering.* All students are required to follow a curriculum covering the courses listed below plus a business course and one non-technical elective. Students entering the program must have completed two years of pre-engineering, university-parallel transfer courses including Mathematics through Calculus, one year each of Chemistry, Physics (with Calculus), English Composition, Humanities, Social Science, plus electives to make a total of at least 60 semester or 90 quarter hours. Practical work is stressed in the "Ocean Engineering Laboratory" and "Summer Practical Work and Independent Study Courses."

The Department of Ocean Engineering provides a comprehensive, practical curriculum in science and engineering which will prepare the student to perform engineering tasks in the ocean. The curriculum prepares the student for graduate study in ocean engineering and for professional positions in industry, government and science.

The Ocean Engineering program covers integrated work units encompassing basic engineering sciences and mathematics; study of the ocean environment and its relationship to other sciences and engineering; instrumentation and processing of ocean engineering data; and their application to engineering problems connected with working in, on, or exploiting the resources of the oceans.

Emphasis is placed on the solution of problems related to working in the ocean in areas such as underwater acoustics, fluid mechanics, structures, electronics, instrumentation, and materials. A summer quarter is devoted to practical work in ocean engineering. The following courses are offered in conjunction with the University's degree program (the credits shown are quarter credits):

| | | |
|----------|--|---|
| OCEN 404 | Oceanography I | 3 |
| OCEN 414 | Elements of Electrical Engineering I | 4 |
| OCEN 425 | Statics | 4 |
| OCEN 437 | Thermodynamics I | 3 |
| OCEN 405 | Oceanography II | 3 |
| OCEN 415 | Elements of Electrical Engineering II | 4 |
| OCEN 426 | Dynamics | 4 |
| OCEN 438 | Thermodynamics II | 3 |
| OCEN 406 | Oceanography III | 3 |
| OCEN 407 | Ocean Engineering Laboratory | 2 |
| OCEN 416 | Elements of Electrical Engineering III | 4 |
| OCEN 429 | Fluid Mechanics I | 3 |
| OCEN 434 | Strength of Materials I | 3 |
| OCEN 450 | Practical Work and Independent Study | 3 |
| OCEN 401 | Engineering Materials I | 4 |

*(An M.S. in Engineering (Ocean Engineering) is proposed for the 1969-70 academic year.)

| | | |
|-----------------------------------|------------------------------------|---|
| OCEN 423 | Instrumentation | 3 |
| OCEN 420 | Acoustics | 3 |
| OCEN 430 | Fluid Mechanics II | 3 |
| OCEN 435 | Strength of Materials II | 3 |
| OCEN 402 | Engineering Materials II | 4 |
| OCEN 421 | Underwater Acoustics I | 3 |
| OCEN 431 | Fluid Mechanics III | 3 |
| OCEN 440 | Heat Transfer | 3 |
| OCEN 412 | Shock & Vibration | 3 |
| OCEN 422 | Underwater Acoustics II | 3 |
| OCEN 432 | Underwater Structures | 3 |
| OCEN 460 | Ocean Engineering Seminar | 1 |
| Supporting Science Courses | | |
| MATH 470 | Differential Equations | |
| MATH 427 | Statistical Methods | |
| CHEM 307 | Introduction to Physical Chemistry | |
| BIOL 435 | Marine Biology | |

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Ocean Engineering

Stephan, Charles R., B.S., Chairman and Professor of Ocean Engineering
 McAllister, Raymond F., Ph.D., Professor of Oceanography
 Tessin, William, Ph.D., Professor of Ocean Engineering
 Davidson, James B., M.S., Associate Professor of Ocean Engineering
 Mudge, William A., Ph.D., Visiting Professor
 Brannock, Robert N., Ph.D., Associate Professor of Ocean Engineering
 Villanueva, José, Ph.D., Associate Professor of Ocean Engineering
 Graham, Peter, Ph.D., Assistant Professor of Ocean Engineering
 Case, Robert O., Ph.D., Assistant Professor of Ocean Engineering
 Manring, James E., M.E., Assistant Professor of Ocean Engineering
 Monroe, Frederick F., B.A., Assistant Professor
 Lee, Thomas N., M.S., Visiting Assistant Professor of Oceanography
 Hartt, William H., Ph.D., Instructor of Ocean Engineering

To obtain further information, address all inquiries directly to:

Professor Charles R. Stephan
 Chairman, Department of Ocean Engineering
 Florida Atlantic University
 Boca Raton, Florida 33432

UNIVERSITY OF FLORIDA
Gainesville, Florida

The Coastal and Oceanographic Engineering Department facilities include a laboratory equipped with a covered wave tank for air-sea interaction experiments, a second wave tank for general experiments, a wave basin for model studies of sections of coastlines, and various other laboratory facilities. Equipment required for field studies, including two small survey vessels, is available within the department.

The University offers the degrees of M.S. and Ph.D. in Civil Engineering with an emphasis in Coastal and Oceanographic Engineering.*

The following courses are offered in conjunction with these programs:

Undergraduate Course

| | | |
|-----|---|---|
| 400 | Introduction to Coastal and Oceanographic Engineering | 3 |
|-----|---|---|

Graduate Courses—Department of Coastal and Oceanographic Engineering

| | | |
|-----|--|---------|
| 610 | Ocean Waves 1: Linear Theory | 4 |
| 611 | Ocean Waves 2: Nonlinear Theory | 4 |
| 612 | Ocean Wave Spectra | 4 |
| 613 | Long Waves and Tides | 4 |
| 620 | Coastal Structures 1: Theory | 4 |
| 621 | Coastal Structures 2: Applications | 4 |
| 630 | Littoral Processes | 4 |
| 631 | Simulation Techniques | 4 |
| 632 | Selected Field and Laboratory Problems | 3-8 |
| 640 | Physical Oceanography | 4 |
| 641 | Air-Sea Interaction 1: Microscale | 4 |
| 642 | Air-Sea Interaction 2: Macroscale | 4 |
| 643 | Advanced Topics in Coastal and Oceanographic Engineering | 1-6 |
| 699 | Master's Research | 0-9 |
| | | Max. 24 |

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Coastal and Oceanographic Engineering

Dean, Robert G., Sc.D., Professor and Chairman, Department of Coastal and Oceanographic Engineering

Jen, Yuan, Ph.D., Assistant Professor of Coastal and Oceanographic Engineering

Partheniades, Emmanuel, Ph.D., Associate Professor of Coastal and Oceanographic Engineering

Shemdin, Omar H., Ph.D., Assistant Professor of Coastal and Oceanographic Engineering

To obtain further information, address all inquiries directly to:

Department of Coastal and Oceanographic Engineering

Dr. R. G. Dean

Department of Coastal and Oceanographic Engineering

University of Florida

Gainesville, Florida 32601

*(An M.S. in Coastal and Oceanographic Engineering is proposed.)

**GULF COAST TECHNICAL INSTITUTE
MISSISSIPPI STATE UNIVERSITY
Gulfport, Mississippi**

The Institute has well-equipped design and electronic laboratories and computing facilities. All curriculums at the Gulf Coast Technical Institute lead to the Bachelor of Engineering Technology degree awarded by Mississippi State University. The Marine Science courses are offered as electives to the curriculums of Construction Engineering Technology and Electronic Engineering Technology as a Marine option.

Marine Engineering Technology

| | | |
|----------|-----------------------------------|---|
| MAT 2004 | Shipbuilding Technology I | 3 |
| MAT 2103 | Marine Engineering Technology I | 3 |
| MAT 2603 | Naval Architecture Technology I | 3 |
| MAT 3023 | Shipbuilding Technology II | 3 |
| MAT 3114 | Marine Engineering Technology II | 4 |
| MAT 3123 | Marine Engineering Technology III | 3 |
| MAT 3404 | Shipboard Ventilation | 4 |
| MAT 3614 | Naval Architecture Technology II | 4 |
| MAT 3623 | Naval Architecture Technology III | 3 |
| GET 2303 | Applied Thermodynamics | 3 |
| GET 2403 | Metals Technology | 3 |
| GET 3313 | Applied Fluid Mechanics | 3 |
| GET 3323 | Applied Dynamics | 3 |

Marine Science

| | | |
|----------|--------------------------------------|---|
| GET 2403 | Oceanography I | 3 |
| GET 2503 | Oceanography II | 3 |
| GET 3023 | Marine Structures | 3 |
| GET 3003 | Introduction to Underwater Acoustics | 3 |

The instructional staff for the courses listed above consists of the following:

Kennedy, Charles E., M.S., Assistant Professor of Mechanical Engineering Technology

Leavitt, Clyde M., B.S., Adjunct Associate Professor of Marine Engineering Technology

To obtain further information, address all inquiries directly to:

Director
Gulf Coast Technical Institute
Box 458
Gulfport, Mississippi 39501

UNIVERSITY OF HAWAII
Honolulu, Hawaii

The major research facility is the Look Laboratory of Oceanographic Engineering. It is the first structure of the Kewalo Oceanographic Research Center, and supports research activity that has direct bearing on many ocean-related problems occurring throughout the state of Hawaii. Facilities are being doubled in capacity and capability. Construction is underway, and will be completed in 1969, ready for operation by summer or fall of 1969.

The Master of Science in Ocean Engineering is an interdepartmental graduate program contributed to by the Departments of Oceanography, Civil Engineering, Electrical Engineering, and Mechanical Engineering. Plan A (thesis program) is recommended but Plan B (non-thesis) may be permitted. Choice of plan must be made before 14 credits of graduate work applicable to the degree have been completed. A foreign language is not required.

Plan A requires a minimum total of 30 credit hours, including 24 credit hours of course work and 8 credit hours of thesis research. Six credit hours of course work may be taken outside the College of Engineering and the Department of Oceanography. At least 8 credits must be in courses numbered 600-799.

Plan B requires 30 credits of course work. At least 6 credit hours shall be taken outside the College of Engineering and the Department of Oceanography. At least 8 credits must be in engineering courses. Two graduate seminars in engineering or oceanography are required. A minimum of 18 credits must be in courses numbered 600-799.

The following courses are required of all students in ocean engineering:

| | | | |
|--------------|-------------------------------|----|-----|
| O.E. 603 | Ocean Engineering Environment | F | 3 |
| O.E. 697-698 | Ocean Engineering Seminar | Sp | 1-1 |
| Ocean 620 | Physical Oceanography | F | 3 |
| C.E. 641 | Ocean Engineering | F | 3 |

Six credits of approved courses may be selected from physics, mathematics, chemistry, or geosciences. Additional courses normally will be selected from the following list:

Ocean Engineering

| | | |
|-----|--|---|
| 605 | Naval Architecture in Ocean Engineering | 3 |
| 606 | Dynamics of Offshore Floating Structures | 3 |
| 608 | Submarine Vehicle Naval Architecture | 3 |

Civil Engineering

| | | |
|-----|---|---|
| 621 | Advanced Fluid Mechanics I | 3 |
| 622 | Advanced Fluid Mechanics II | 3 |
| 635 | Environmental and Sanitary Engineering Chemistry | 4 |
| 636 | Environmental and Sanitary Engineering Microbiology | 4 |
| 642 | Coastal and Harbor Engineering | 3 |
| 644 | Ocean Hydrodynamics Laboratory | 2 |
| 655 | Advanced Soil Mechanics | 3 |
| 671 | Theory of Elasticity | 3 |
| 674 | Stability of Structures | 3 |
| 675 | Theory of Vibrations | 3 |
| 676 | Structural Dynamics | 3 |
| 678 | Theory of Plates | 3 |
| 679 | Theory of Thin Shells | 3 |
| 681 | Advanced Indeterminate Structures | 3 |
| 682 | Numerical Methods of Stress Analysis | 3 |
| 683 | Advanced Reinforced Concrete Design | 3 |

Electrical Engineering

| | | |
|-----|--|---|
| 623 | Advanced Electronic Instrumentation | 3 |
| 651 | Advanced Feedback Control Systems | 3 |
| 652 | Optimization Techniques in Control Systems | 3 |

Electrical Engineering—Continued

| | | |
|---------|---|-----|
| 655 | Sampled-Data Control Systems | 3 |
| 661 | Theory of Digital Machines | 3 |
| 671–672 | Electromagnetic Theory and Applications | 3–3 |

Mechanical Engineering

| | | |
|---------|-------------------------------------|-----|
| 611 | Classical Thermodynamics | 3 |
| 621–622 | Conduction Heat Transfer | 3–3 |
| 631 | Mechanical Properties of Materials | 3 |
| 636 | Materials for the Ocean Environment | 2 |

Oceanography

| | | |
|-----|--------------------------------|---|
| 622 | Geological Oceanography | 3 |
| 623 | Chemical Oceanography | 2 |
| 632 | Littoral Geological Processes | 3 |
| 640 | Advanced Physical Oceanography | 3 |
| 642 | Recent Marine Sediments | 3 |
| 660 | Ocean Wave Theory | 3 |
| 661 | Tides | 3 |

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Bretschneider, C. L., Ph.D. (Chairman)—Civil Engineering, Physical Oceanography
Adams, W. M., Ph.D.—Geophysics, Geophysical Engineering
Burbank, N., Sc.D.—Environmental Engineering
Grace, R., Ph.D.—Civil Engineering
Larsen-Badse, J., Ph.D.—Materials Science
Williams, J. A., Ph.D.—Civil and Ocean Engineering, Hydrodynamics
St. Denis, M., Dr.Sc.—Naval Architecture
Allmendinger, E.,—Naval Architecture

To obtain further information, address all inquiries directly to:

Dr. Charles L. Bretschneider
Department of Oceanography
University of Hawaii
Honolulu, Hawaii 96822

UNIVERSITY OF HOUSTON

Houston, Texas

Marine sciences are taught in the Cullen College of Engineering and in the College of Arts and Sciences. The University has a SDS Sigma 7 digital computing system available to qualified students, and the Cullen College of Engineering is currently adding a large scale modern hybrid computing facility for engineering research. In addition, the Engineering School has recently acquired two large analog computing facilities from the General Electric Company and a large scale digital computer ideal for instructional purposes from NASA. Sea going vessels are available to all students through ocean related programs of the Geology and Biology Departments, as well as access to offshore drilling platforms of the oil industry. The University and Texas A&M University are developing a cooperative program in ocean engineering which will make available a large oceanographic research vessel and additional shore-based facilities. The University is a member of the Gulf Universities Research Corporation, which is described in the Consortia section of this publication.

The Cullen College of Engineering has recently moved into a new engineering building with adequate classroom and laboratory facilities for instruction in oceanography, ocean engineering, and related fields. In the College of Arts and Sciences, the Department of Geology has about 26,500 square feet of space, Biophysics about 9000 square feet, and Biology about 50,000 square feet. Modern research facilities, including wet labs and cold storage, are available on the main campus, and supplementary facilities are being developed in the Galveston Bay area.

The Master of Science and Doctor of Philosophy Degrees with Ocean Engineering options are granted in Chemical Engineering, Civil Engineering, Electrical Engineering, Mechanical Engineering, and Petroleum Engineering. In addition, Master of Science (Undifferentiated) and Doctor of Philosophy (Undifferentiated) Degrees may be granted in interdisciplinary ocean engineering programs and in the College of Arts & Sciences.

The requirements for these degrees are as follows:

1. Master of Science

Twenty-four or more semester hours of academic work are required in addition to a thesis, which counts for a minimum of six semester hours. At least 12 semester hours, excluding the thesis, must be completed within the major field, and, at the discretion of the department chairman, 18 semester hours may be required in the major field. No student may register for credit for more than 13 semester hours, exclusive of thesis and seminar, in any one semester.

The student must satisfactorily defend his thesis, prior to its acceptance, before a committee appointed by the department chairman and approved by the Dean of the Cullen College of Engineering.

Before a student has completed 12 semester hours of graduate study, he may be required to take a written examination covering the fundamentals of engineering and mathematics. If he fails to perform satisfactorily in any given area, he will be required to take additional work to remove the indicated deficiency.

2. Doctor of Philosophy

Requirements:

- a. A minimum of 52 semester hours of approved graduate study beyond the master's degree, to include the following:
 - (1) Major courses, 7-10 semester hours
 - (2) Electives in related fields, 12-15 semester hours
 - (3) Research and Dissertation, 30 semester hours
- b. A minimum of two semesters and two summer sessions of residence in full-time graduate study.
- c. Successful completion of written qualifying examinations.
- d. Technical reading examination or approved academic training (6 semester hours) in a modern foreign language (excluding a student's native language) pertinent to the individual research program.

- e. Original research work, leading to a publishable contribution to engineering science, must be carried out under the direction of a faculty member and, upon completion, the candidate must defend the written dissertation in a final oral examination.
- f. Admission to candidacy: After completing the qualifying examination, the foreign language requirement, and 30 semester hours of the program, and with the approval of the department, the student will be admitted to candidacy.

The Cullen College of Engineering of the University of Houston has undergraduate programs in chemical, civil, electrical, industrial, and mechanical engineering. In addition, these departments have graduate course offerings in many areas of special interest to ocean engineering. Some of the most significant of these courses in the Chemical Engineering Department are:

| | |
|-------------|--|
| ChE 530 | Corrosion |
| ChE 631:632 | Mathematical Methods in Chemical Engineering |
| ChE 664 | Flows Through Porous Media |
| ChE 731 | Advanced Fluid Mechanics I |
| ChE 733 | Gas Dynamics II |
| ChE 735 | Advanced Fluid Mechanics II |
| ChE 736 | Advanced Fluid Mechanics III |

The Department of Electrical Engineering also offers supporting course offerings for ocean engineering. Some of the most significant of the electrical engineering courses which are applicable to ocean engineering development include:

| | |
|------------|---|
| EE 575 | Control Engineering |
| EE 576 | Communication Theory |
| EE 617:618 | Propagation and Microwave Laboratory |
| EE 630 | Foundations of Analysis |
| EE 631 | Information Theory |
| EE 633 | Control System Design |
| EE 637 | Advanced Electromagnetic Waves |
| EE 663 | Environmental Biotechnology |
| EE 664 | Systems Biotechnology |
| EE 669 | Ocean Engineering Instrumentation |
| EE 690 | Engineering Analysis I |
| EE 691 | Engineering Analysis II |
| EE 737 | Statistical Wave Propagation |
| EE 739 | Advanced Topics In Electromagnetic Theory |

These courses are in addition to programs in electronics, control engineering, information theory, and hybrid computer applications.

The Mechanical Engineering Department at the University of Houston offers courses in fluid mechanics, hydrodynamics, and vibration analysis—all of which are pertinent to an ocean engineering program. Some of the most significant courses currently being offered in Mechanical Engineering include:

| | |
|--------|---|
| ME 565 | General Acoustics |
| ME 571 | Vibration Analysis |
| ME 638 | Aerothermodynamics |
| ME 660 | Introduction to Advanced Dynamics |
| ME 661 | Advanced Vibration Analysis |
| ME 662 | Advanced Dynamics |
| ME 665 | Physical Acoustics |
| ME 666 | Engineering Acoustics |
| ME 690 | Engineering Analysis I |
| ME 691 | Engineering Analysis II |
| ME 731 | Advanced Fluid Mechanics I—Laminar Flow |
| ME 732 | Hydrodynamics I |
| ME 733 | Gas Dynamics II |

| | |
|--------|--|
| ME 734 | Hydrodynamics II |
| ME 735 | Advanced Fluid Mechanics II—Turbulent Flow |
| ME 736 | Advanced Fluid Mechanics III—Boundary Layer Flow |
| ME 739 | Hydrodynamics of Waves |
| ME 760 | Nonlinear Analysis |

The Mechanical Engineering Department has a special emphasis on underwater acoustics, including underwater horn design and propagation characteristics.

Although ocean engineering is taught as an interdisciplinary program at the University of Houston, the primary responsibility for curricula development rests with the Department of Civil Engineering. The ocean engineering effort is significantly aided by programs in environmental engineering, structures, and soil mechanics. Principal courses which pertain to ocean engineering in the Civil Engineering Department include:

| | | |
|--------|---|---|
| CE 461 | Environmental Engineering Practices | 3 |
| CE 533 | Evaluation of Water Quality in Natural Waters | 3 |
| CE 573 | Ocean Waves | 3 |
| CE 582 | Air Monitoring and Measurements | |
| CE 594 | Water Monitoring and Measurements | |
| CE 630 | Hydromechanics | 3 |
| CE 631 | Hydraulics of Open Channel Flow | 3 |
| CE 637 | Advanced Structural Analysis | |
| CE 639 | Soil Dynamics | |
| CE 666 | Oceanographic Aspects of Coastal Engineering | 3 |
| CE 667 | Waterways, Ports, and Harbors | |
| CE 668 | Environmental Factors in Ocean Engineering | 3 |
| CE 669 | Ocean Engineering Instrumentation | 3 |
| CE 681 | Microclimatology | 3 |
| CE 691 | Advanced Water and Wastewater Treatment | |
| CE 731 | Advanced Hydrodynamics | |
| CE 734 | Hydraulic Transients | 3 |
| CE 735 | Hydrodynamics of Waves | 3 |
| CE 736 | Nonlinear Ocean Waves | |
| CE 737 | Matrix Analysis of Structures | 3 |
| CE 738 | Dynamics of Structures | 3 |

Related courses are also offered in the following departments:

Biology Department

| | |
|----------------|-------------------------------|
| BIO 426A; 426B | Ecological Methods |
| BIO 431 | Phytopathology |
| BIO 436 | Ecology |
| BIO 443 | Comparative Animal Physiology |
| BIO 444A | Marine Biology |
| BIO 633 | Marine Plants |
| BIO 633A | Physiology of Marine Bacteria |
| BIO 683A | Physiology of Marine Animals |

Biophysics Department

| | |
|-------------|-----------------------------|
| BPH 432:433 | General Biophysics |
| BPH 421 | Biophysical Instrumentation |
| BPH 633 | Molecular Biophysics |

Geology Department

| | |
|---------|-----------------------|
| GEO 380 | Geology for Engineers |
| GEO 431 | Earth Physics |
| GEO 438 | Physical Oceanography |
| GEO 490 | Earth Science Studies |
| GEO 631 | Marine Geology |

Geology Department—Continued

| | |
|---------|--------------------------------|
| GEO 633 | Nearshore Processes & Problems |
| GEO 667 | Geochemistry I |
| GEO 668 | Geochemistry II |
| GEO 669 | Organic Geochemistry |
| GEO 680 | Advanced Sedimentation |
| GEO 690 | Paleontological Taxonomy |
| GEO 691 | Micropaleontology |
| GEO 692 | Biostratigraphy |
| GEO 694 | Paleoecology |
| GEO 696 | Stratigraphic Analysis |

College of Law

| | |
|-----------|------------------------------|
| Law 521 W | International Commercial Law |
| Law 521 Y | Public International Law |

Physics

| | |
|---------|-----------------------|
| PHY 330 | Physical Meteorology |
| PHY 430 | Dynamical Meteorology |

Geography

| | |
|---------|--------------------------------|
| GGY 131 | Elements of Physical Geography |
| GGY 215 | Field Mapping |
| GGY 333 | Climates |

The instructional staff for the courses listed above consists of the following:

Cullen College of Engineering

Blumberg, Randolph, Ph.D., Associate Professor of Ocean Engineering
Castellanos, Leo John, M.E., Professor of Mechanical Engineering
Dalton, Charles, Ph.D., Associate Professor of Mechanical Engineering
Dukler, A. E., Ph.D., Professor of Chemical Engineering
Finch, Robert D., Ph.D., Associate Professor of Mechanical Engineering
Ghazzaly, Osman I., Ph.D., Assistant Professor of Civil Engineering
Graff, William J., Ph.D., Professor of Civil Engineering
Hayre, Harbhajan S., D.Sc., Professor of Electrical Engineering
Hwang, Neddy H.C., Ph.D., Associate Professor of Civil Engineering
Muster, Douglas F., Ph.D., Professor of Mechanical Engineering
Myrick, H. Nugent, Sc.D., Associate Professor of Civil Engineering
Overton, Harold L., M.S., Associate Professor of Petroleum Engineering
Schneider, William P., S.M., Professor of Electrical Engineering
White, Ardis H., Ph.D., Professor of Civil Engineering

Biology Department

Fair, Jerrell F., Ph.D., Assistant Professor of Biology
Lawrence, Addison L., Ph.D., Associate Professor of Biology
Mann, James E., Ph.D., Assistant Professor of Biology
Wright, Howard O., Ph.D., Assistant Professor of Biology

Biophysics Department

Bartel, Allen H., Ph.D., Professor of Biology and Biophysics

Geography Department

Hyer, June, Ph.D., Professor of Geography

Geology

Bishop, Margaret S., Ph.D., Professor of Geology
Lohse, E. Alan, Ph.D., Associate Professor of Geology
Maddocks, Rosalie, Ph.D., Assistant Professor of Geology
Sadlick, Walter, Ph.D., Associate Professor of Geology
Van Sicken, DeWitt C., Ph.D., Professor of Geology

College of Law

Mixon, John, L.L.M., Professor of Law

Physics Department

Graves, Leon, S.M., Associate Professor of Physics

To obtain further information, address all inquiries directly to:

**Dr. Randolph Blumberg, Chairman
Ocean Engineering Committee
Cullen College of Engineering
University of Houston
Houston, Texas 77004**

**Dr. E. Alan Lohse
Geology Department
College of Arts and Science
University of Houston
Houston, Texas 77004**

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge, Massachusetts

Over the past decade the Massachusetts Institute of Technology has developed a wide range of unique facilities for applied research related to the utilization of the oceans and the ocean resources. In addition to the vast facilities in basic and engineering research in the various departments of the Institute and the unique facilities of the Instrumentation Laboratory and the Information Processing Services Center as well as those of the Woods Hole Oceanographic Institution (available to MIT through the joint MIT/WHOI Program), the following special marine-oriented facilities are available: variable pressure water tunnel, ship model towing tank, acoustics and vibration laboratory, MIT ship structures laboratory, research vessel SHROCK, coastal engineering model basin, wave channel, sedimentation flume, reservoir stratification model, pressure testing facility, and a stroboscopic light laboratory.

The following degrees are offered in the Department of Naval Architecture and Marine Engineering:

1. B.S. in Naval Architecture and Marine Engineering

All undergraduate students are required to take 68 units in the academic area of Humanities and Social Science. In addition, 12 units of Chemistry subject matter, 24 units of Physics and 24 units of Calculus are required. Each student must fulfill the requirement of satisfactorily completing 12 units of credit in a laboratory course. All of the foregoing requirements involve subjects outside the Department of Naval Architecture and Marine Engineering. The Departmental requirements include the following mandatory subjects:

| | | |
|--------|--|----|
| 2.01 | Mechanics of Solids | 12 |
| 2.02 | Introduction to System Dynamics | 12 |
| 2.201 | Fluid Mechanics | 12 |
| 2.403 | Thermodynamics | 12 |
| 3.141 | Science of Materials | 12 |
| 13.00T | Introduction to Marine Hydrodynamics | 12 |
| 13.20 | Energy Conversion Systems and Components | 12 |
| 13.30T | Ship Structural Analysis and Design | 12 |
| 13.40 | Introductory Ship Design | 9 |
| 18.034 | Differential Equations | 12 |
| 18.05 | Advanced Calculus for Engineers | 12 |
| | Thesis | 9 |

The total units required include

| | |
|---------------------------------|-----------|
| Institute Requirements | 140 |
| Mandatory Departmental Subjects | 153 |
| Unrestricted Electives | 67 |
| | <hr/> 360 |

2. M.S. in Shipping and Shipbuilding Management

3. M.S. in Marine Engineering

4. M.S. in Naval Architecture

5. M.S. in Naval Engineering

6. M.S. in Ocean Engineering

A program of graduate study in the Department is almost entirely under the control of the student, with assistance in his planning by his Graduate Registration Officer. An acceptable graduate program of 72 credit units plus an acceptable thesis leads to the degree of Master of Science in Naval Architecture and Marine Engineering or in Ocean Engineering; this program can usually be completed in one academic year if it is based on an undergraduate curriculum equivalent in scope and emphasis to that available in the Department.

Deficiencies in undergraduate preparation must be removed prior to the award of any of the degrees implying specification. This may be accomplished concurrently with graduate work if the

deficiencies are not extensive. Undergraduate subjects so required are not acceptable to the Department in partial fulfillment of the advanced degree requirements. Somewhat less broad undergraduate work is appropriate for candidates for the degree of Master of Science without specification, if accompanied by correspondingly increased competence in areas pertinent to the proposed graduate program.

The program of studies for an advanced degree must be acceptable to the Departmental Committee on Graduate Students. Unless special approval is given by this Committee, candidates for any graduate degree are expected to include in their programs at least one term of advanced mathematics beyond the requirements of the Department's undergraduate curriculum. The program for an M.S. degree must include a minimum of 72 subject units plus a thesis acceptable to the Department. A minimum of 48 of the 72 units must be "A" subjects.

To be recommended for a Master's degree, a student must have, in addition to a clear record in a program of graduate study and research as defined above, a scholastic standing of a distinctly high grade. The residence requirement for the Master's degree is one full academic term.

7. Nav. E.—Naval Engineer

8. Nav. A.—Naval Architect

9. Mar. Mech. E.—Marine Mechanical Engineer

10. Ocean E.—Ocean Engineer

The objective of a program leading to an Engineer degree is a more advanced level and a broader range of competence in engineering and science than that required for the Master's degree, but with less emphasis on creative research than that characterizing a doctoral program. In general terms, the Master's degree requires a minimum of one academic year and the Engineer degree two academic years beyond a baccalaureate in the same field.

The requirements for an Engineer degree is the satisfactory completion of a program of advanced study and research approved by the Department. The minimum program consists of at least 162 subject units and the completion of an acceptable thesis. A department may accept a Master's thesis of superior quality for the Engineer degree.

A graduate of the Institute who enrolls for an Engineer degree in the same department in which he received his Bachelor's degree, or others with equivalent preparation, may complete the requirements for that degree in four academic terms; a student with less direct or extensive preparation will require a longer time.

The caliber and scope of the Master's and Engineer theses are, in general, such as to require the equivalent of the full time of a student for at least a half of a term. Many theses may require a somewhat longer time. Every degree candidate working on a thesis is expected to register for the appropriate number of hours per week devoted to thesis in all periods during which his thesis research is actually in progress.

A program for an Engineer degree ordinarily includes two subjects in the area of economics, industrial management, or political science, and at least 12 units of comprehensive design, such as DESIGN OF A WATERBORNE VEHICLE (13.42), or the equivalent. A single thesis will generally be acceptable for both the Master of Science and Engineer degrees, provided it is appropriate to the specifications of both degrees.

The residence requirement for the Engineer degree is two full academic terms.

11. Sc.D.—Doctor of Science

12. Ph.D.—Doctor of Philosophy

To obtain the degree of Doctor of Science or Doctor of Philosophy usually requires a minimum of three years of graduate work if the thesis can be completed in one year. Specialization in any aspect of naval architecture, marine engineering, or ocean engineering is appropriate.

The three basic requirements for a doctorate are:

1. Completion of a program of advanced study, including a general examination.
2. Demonstration of proficiency in modern foreign languages, as explained in detail below.
3. Completion and oral defense of a thesis on original research.

The program of advanced study and research may be selected in any field approved by the Department. The thesis is in this same field. The program often comprises subject areas reaching into

several departments. If the field requires substantial participation by two or more departments, an interdepartmental faculty committee may be appointed by the Dean of the Graduate School to advise with a Graduate Registration Officer in the administration of the student's program.

Each doctoral candidate will have a general examination in his field at such time and in such manner as his departmental or interdepartmental committee approves. This examination consists of both oral and written parts.

Each candidate for a doctorate must demonstrate to the Department of Modern Languages and Linguistics:

Either

1. Intermediate competence in speaking and reading one modern foreign language

or

2. Ability to read and translate the scientific literature of his field of specialization from two modern foreign languages into English.

The caliber and scope of the doctoral thesis are such as to require, in all but very exceptional cases, the equivalent of at least one full-time academic year of research. Many doctoral researches require a substantially longer time. Each doctoral candidate is expected to register for the appropriate number of units of thesis in all periods during which work pertaining thereto is actually in progress.

The residence requirement for a doctorate is two full academic years.

The following courses are offered in conjunction with the above programs:

Department of Naval Architecture and Marine Engineering

| | | | |
|----------|---|-------|----|
| 13.00T | Introduction to Marine Hydrodynamics | Sp | 12 |
| 13.01 | Applied Hydrostatics | Su | 10 |
| 13.02T | Marine Hydrodynamics | F, Sp | 12 |
| 13.03T | Advanced Hydromechanics of Ship Design (A) | Sp | 9 |
| 13.04T | Two-Dimensional Hydrofoil Theory (A) | F | 12 |
| 13.05T | Three-Dimensional Hydrofoil Theory (A) | Sp | 12 |
| 13.07 | Free Surface Hydrodynamics (A) | F | 9 |
| 13.08T | Stability and Motion Control of Ocean Vehicles (A) | F | 9 |
| 13.10T | Introduction to Structural Mechanics | F | 9 |
| 13.11T | Theory of Plates and Shells (A) | F | 9 |
| 13.12T | Marine Structures (A) | Sp | 9 |
| 13.13T | Plastic Analysis of Structures | Sp | 9 |
| 13.15T | Welding Engineering (A) | Sp | 6 |
| 13.16J.T | Properties of Metals | Sp | 11 |
| 13.20 | Energy Conversion Systems and Components | Sp | 12 |
| 13.21 | Ship Propulsion (A) | F | 6 |
| 13.22 | Naval Ship Propulsion (A) | F | 12 |
| 13.23 | Propulsion System Reliability and Control (A) | Sp | 9 |
| 13.24T | Propulsion Hydrodynamics (A) | F | 6 |
| 13.25 | Advanced Naval Electrical Engineering (A) | Sp* | 9 |
| 13.30T | Ship Structural Analysis and Design | F | 12 |
| 13.32T | Ocean Engineering Structures | F | 9 |
| 13.34T | Ship Structural Design I (A) | F | 5 |
| 13.35T | Naval Structural Design (A) | F* | 5 |
| 13.36 | Ocean Engineering Structural Design | Sp | 5 |
| 13.39T | Analysis of Techniques for Fabricating Structures (A) | Sp | 6 |
| 13.40 | Introductory Ship Design | Sp | 9 |

*Offered in Alternate Years

Department of Naval Architecture and Marine Engineering—Continued

| | | | |
|--------|--|-------|-----|
| 13.41 | Principles of Ship Design (A) | F | 11 |
| 13.42 | Design of a Waterborne Vehicle (A) | Sp | LAB |
| 13.43 | Naval Ship-System Design I (A) | Su | 9 |
| 13.44 | Naval Ship-System Design II (A) | F | 5 |
| 13.45 | Principles of Naval Ship Design (A) | F | 9 |
| 13.46 | Conceptual Design of Naval Ships (A) | Sp | 12 |
| 13.47J | Special Studies in Systems Engineering (A) | Sp | 12 |
| 13.50 | Computer Application to Marine Problems | Sp | 8 |
| 13.51 | Computer Systems for Naval Architecture and Marine Engineering (A) | Sp | 6 |
| 13.60 | Application of Operational Methods | F | 12 |
| 13.61 | Decision Processes in Ship Operation and Construction (A) | Sp | 9 |
| 13.62 | Shipping Economics (A) | Sp | 9 |
| 13.64 | Hydrospace Vehicles | Sp | 6 |
| 13.65 | Ship Production Analysis (A) | F | 6 |
| 13.70 | Special Problems in Naval Architecture and Marine Engineering I | F, Sp | LAB |
| 13.71 | Special Problems in Naval Architecture and Marine Engineering II | F, Sp | LAB |
| 13.72 | Methods of Harmonic and Statistical Analysis (A) | Sp | 9 |
| 13.80T | Mechanical Vibrations (A) | F | 9 |
| 13.81T | Acoustics and Structural Vibrations | F | 9 |
| 13.82T | Acoustics and Shock Response of Marine Structures (A) | Sp | 9 |
| 13.83T | Hydroacoustics (A) | Sp | 9 |
| 13.84T | Flow Noise (A) | Sp | 12 |
| 13.92J | Public Policy and Use of the Seas | F | 9 |
| 13.93 | Ocean Engineering Systems | F | 6 |
| 13.94 | Modern Ocean Engineering and International Affairs | Sp | 6 |

Department of Metallurgy and Materials Science

| | | | |
|------|---------------|----|---|
| 3.54 | Corrosion (A) | Sp | 8 |
|------|---------------|----|---|

Department of Civil Engineering

| | | | |
|-------|-------------------------------------|----|---|
| 1.631 | Advanced Hydromechanics I (A) | F | 9 |
| 1.632 | Advanced Hydromechanics II (A) | Sp | 9 |
| 1.681 | Experimental Hydromechanics (A) | F | 6 |
| 1.683 | Experimental Hydromechanics (A) | Sp | 6 |
| 1.69 | Waves and Coastal Processes (A) | Sp | 9 |
| 1.70 | Mechanics of Sediment Transport (A) | Sp | 6 |

The Institute also offers a graduate degree program in marine science which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Naval Architecture and Marine Engineering

Keil, Alfred A. H., Dr. Rer. Nat., Head of Department and Professor of Naval Architecture and Marine Engineering

Abkowitz, Martin A., Ph.D., Professor of Naval Architecture

Cummings, Damon E., Ph.D., Assistant Professor of Naval Architecture

Devanney, John W., III, Ph.D., Assistant Professor of Naval Architecture

Evans, John H., B.Eng., Professor of Naval Architecture

Frankel, Ernst G., Mar.Mech.E., Professor of Marine Engineering

Department of Naval Architecture and Marine Engineering—Continued

Frisch, Franz A. P., Diplom Ingenieur, Lecturer of Marine Transportation
Horn, Dean A., Nav.E., Professor of Naval Construction
Jones, Norman, Ph.D., Assistant Professor of Naval Architecture
Junger, Miguel C., Sc.D., Senior Lecturer of Hydroacoustics
Kerwin, Justin E., Ph.D., Professor of Naval Architecture
Leehey, Patrick, Ph.D., Professor of Naval Architecture
Mandel, Philip, B.S., Professor of Naval Architecture
Mansour, Alaa, Ph.D., Assistant Professor of Naval Architecture
Masubuchi, Koichi, D.Eng., Associate Professor of Naval Architecture
Milgram, Jerome H., Ph.D., Assistant Professor of Naval Architecture
Newman, John N., Sc.D., Associate Professor of Naval Architecture
Padelford, Norman J., Ph.D., Professor of Political Science
Pellini, William S., B.S., Senior Lecturer of Ocean Engineering Materials
Powell, S. Curtis, Dott. Ing., Associate Professor of Marine Engineering
Reed, Sherman C., Nav.E., Associate Professor of Naval Engineering
Romberg, Bernhard W., Ph.D., Lecturer of Computer Systems Applications

Department of Metallurgy and Materials Science

Floe, Carl F., Sc.D., Professor of Metallurgy
Uhlig, Herbert H., Ph.D., Professor of Metallurgy

Department of Electrical Engineering

Edgerton, Harold E., Sc.D., Professor of Electrical Measurements, Emeritus

Department of Civil Engineering

Cross, Ralph H., III, Ph.D., Assistant Professor of Civil Engineering
Gelhar, Lynn W., Ph.D., Assistant Professor of Civil Engineering
Harleman, Donald R. F., Sc.D., Professor of Civil Engineering
Ippen, Arthur T., Ph.D., Professor of Civil Engineering
Mei, Chiang C., Ph.D., Associate Professor of Civil Engineering
Perkins, Frank E., Sc.D., Associate Professor of Civil Engineering

To obtain further information, address all inquiries directly to:

Ocean Engineering Information
Admissions Office, Room 3-108
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

UNIVERSITY OF MIAMI
Coral Gables, Florida

Facilities include those of the Institute of Marine Sciences and the School of Engineering. At the Institute, research vessels, extensive oceanographic laboratories, underwater acoustics laboratory, marine corrosion laboratories, ocean measurements facilities, classroom space, library, and digital computer are provided. At the School of Engineering, laboratories in Civil, Electrical, Industrial, and Mechanical Engineering are available to the Ocean Engineering students for course work and research.

The following degrees are offered in the areas indicated:

1. **M.S. in Ocean Engineering.** This is an interdisciplinary program consisting of a minimum of 30 credits at the graduate level, of which six are for a thesis. At least 12 credits must be at the 600 level (open to graduate students only) excluding thesis. PCO 501, PCO 503, and OEN 607 are required of all ocean engineering students and at least 12 credits must be in either ocean engineering or ocean related subjects. The areas of specialization center about underwater structures and coastal engineering, marine corrosion, ocean measurements, and underwater acoustics.

2. **Ph.D. programs** are available in the **Civil Engineering and Mechanical Engineering Departments with specialization in Ocean Engineering.**

3. **Undergraduate programs in Ocean Engineering** are available as options in the **Civil, Electrical, Industrial, and Mechanical Engineering Departments.** These are fully accredited programs in their respective traditional areas, but allow specialization in Ocean Engineering through choice of electives.

The Ocean Engineering, Physical and Chemical Oceanography, and the Electrical, Civil, Industrial, and Mechanical Engineering Departments offer courses related to Ocean Engineering. The following courses are offered in conjunction with the above programs:

| | | |
|---------|---|---|
| PCO 501 | General Oceanography | 3 |
| PCO 503 | General Oceanography Laboratory | 1 |
| OEN 531 | Oceanographic Measurements | 3 |
| OEN 535 | Underwater Acoustics | 3 |
| OEN 541 | Marine Corrosion | 2 |
| OEN 607 | Ocean Engineering Seminar | 1 |
| OEN 610 | Applied Ocean Hydrodynamics | 2 |
| OEN 611 | Engineering of Ocean Systems | 2 |
| OEN 641 | Marine Corrosion Laboratory | 1 |
| OEN 642 | Advanced Marine Corrosion | 2 |
| OEN 690 | Advanced Topics in Ocean Engineering I | 3 |
| OEN 691 | Advanced Topics in Ocean Engineering II | 3 |
| CEN 509 | Coastal Engineering | 3 |
| CEN 691 | Underwater Structures | 3 |
| PCO 613 | Advanced Underwater Acoustics | 3 |
| RES 600 | Thesis | 6 |

Many related courses are available in the School of Engineering and at the Institute of Marine Sciences. These are too numerous to list and are available in the University bulletin.

The University also offers a graduate program in marine science which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Ocean Engineering

Steinberg, John C., Ph.D., Chairman and Professor of Ocean Engineering, Underwater Acoustics

Weinberg, Norman L., Ph.D., Associate Professor of Electrical and Ocean Engineering, Underwater Acoustics and Ocean Instrumentation

Chang, Wen F., Ph.D., Professor of Civil Engineering, Underwater Structures

Department of Ocean Engineering—Continued

Yacoub, Kamal, Ph.D., Associate Professor of Electrical and Ocean Engineering, Oceanographic data analysis

Michel, John F., M.S., Research Scientist, Coastal Engineering and Underwater Structures

Compton, Kenneth G., M.S., Professor of Ocean Engineering, Marine Corrosion

Kronengold, Morton, B.S., Assistant Professor of Ocean Engineering, Ocean Measurements and Underwater Acoustics

DeFerrari, Harry, Ph.D., Assistant Professor of Ocean Engineering, Underwater Acoustics

Frohlich, Hans, Dipl. Ing., Associate Professor of Mechanical Engineering, Coring techniques

Knopf, William C., Ph.D., Dean, School of Engineering, Special Lectures on Ocean Engineering

To obtain further information, address all inquiries directly to:

Dr. John C. Steinberg

Chairman, Ocean Engineering Department

University of Miami

Coral Gables, Florida 33124

THE UNIVERSITY OF MICHIGAN
Ann Arbor, Michigan

The department's research facilities include two ship model basins capable of testing models up to 18 feet in length. One basin is 360 feet long, 22 feet wide, and 11 feet deep. It is spanned by a traveling carriage that tows the model through the water and carries observers and instrumentation for measuring speed, resistance, and so forth. Self-propelled tests are also carried out. The tank is equipped with a false bottom allowing analysis of shallow water effects. It also has a wave-maker allowing model tests in head-on or overtaking waves. The other basin is 100 feet by 60 feet in plan, and 6 feet deep. It is used for ship model tests using radio-controlled, self-propelled models. In its present condition it is used primarily for maneuvering tests. Upon completion of the wave-maker (now under construction) the tank will also allow seakeeping tests with waves coming from any direction.

Other facilities include several small instructional items such as a demonstration propeller tunnel. In addition, the department has available to it all the appurtenances of the Engineering College, notably the Fluids Laboratory (110,000 square feet), the Engineering-Transportation Library (300,000 volumes) and an IBM 360-67-computer system.

The following degrees are offered:

1. BSE (Naval Architecture and Marine Engineering)

The undergraduate student elects one of three options, each of which leads to the degree B.S.E. (Nav. Arch. & Mar. E.)—Bachelor of Science in Engineering (Naval Architecture and Marine Engineering); he thus acquires competence in one division of the field while obtaining a good introduction to the rest. These options are:

Option 1. Naval Architecture relates to the design of ship hulls and includes such topics as form, strength, stability, arrangements, resistance, powering, and methods of preliminary design.

Option 2. Marine Engineering places emphasis on the design of various types of propelling and auxiliary machinery and on their relation to the ship as a whole.

Option 3. Maritime Engineering Science stresses preparation for research and provides a stronger grounding in basic engineering science with less emphasis on design than that found in the other options. It will be normal for students in this option to spend an extra term and receive an additional degree in mathematics or engineering mechanics or to do graduate work toward an M.S.E. degree from this or other departments.

Students wishing to obtain an additional B.S.E. degree in aerospace engineering may do so under a combined program which allows for substantial substitution of courses in one curriculum for those required in the other.

Candidates for the degree B.S.E. (Nav. Arch. & Mar. E.)—Bachelor of Science in Engineering (Naval Architecture and Marine Engineering)—are required to complete the following program:

A. Subjects to be elected or equivalent proficiencies to be demonstrated.

B. Professional and advanced subjects and electives.

Group A Subjects

Group A includes foundation subjects in those fundamental areas of communication, mathematics, and basic sciences that are common to all programs.

Appropriate college credit may be allowed a student for subjects in which he has qualified through the Advanced Placement Program as covered under Admission as a Freshman. Another possibility for attaining advanced credit is through demonstration of equivalent proficiency in any of the Group A subjects.

Generally, suitable Group A subjects, with the possible exception of Engineering Graphics, are offered in liberal arts colleges and community colleges; under conditions of equivalency and satisfactory performance, they are transferable to any engineering program.

Credit is not granted for work experience.

Group B Subjects

Group B for each program is composed basically of "professional and advanced subjects and electives," consisting of a total of 95 credit hours, that will prepare the student for the particular field of engineering he selects.

2. MSE (Naval Architecture and Marine Engineering)

Requirements for the degree include 30 credit hours of graduate studies, approved by the graduate adviser, including at least 10 credit hours of course work in Naval Architecture and Marine Engineering exclusive of those required for the degree of B.S.E. (Nav. Arch. & Mar. E.), a minimum of 5 credit hours of mathematics beyond undergraduate degree level, and cognate subjects. A thesis may also be required. If the applicant's undergraduate work is in a field other than naval architecture and marine engineering, or taken at a non-accredited school, the program adviser may require that he first enter the College of Engineering as an undergraduate special student for one or more terms.

It is possible to obtain the Master of Science in Engineering degree in the combined fields of Naval Architecture and Marine Engineering, and another engineering field, after the student has first been admitted to one department. To do so he must be able to present an acceptable study program endorsed by the program advisers of the two departments involved, showing a minimum of 36 hours of graduate-level courses. The program outline must then be presented to the Dean of the Graduate School for final approval.

3. Naval Architecture (Professional Degree)

The professional degree program requires a minimum of thirty credit hours of work beyond the Master of Science in Engineering level or its equivalent, taken at this University with a grade average of B or better. Successful completion of a qualifying examination for admission to candidacy is required.

The total graduate program shall include:

- a. At least twenty-four hours in the area of the department or program cited in the degree. The department or program advisers may specify these hours in greater detail.
- b. At least six hours devoted to a research, design, or development problem, including a written report covering the work. A committee of faculty members will supervise the work, approve the report, and conduct a final oral examination on this work.
- c. At least three courses in cognate fields other than mathematics.
- d. At least nine hours in mathematics beyond the Bachelor of Science in Engineering mathematics requirements of the department cited in the degree.

4. Ph.D.

The doctor's degree is conferred in recognition of marked ability and scholarship in some relatively broad field of knowledge. A part of the work consists of regularly announced graduate courses of instruction in the chosen field and in such cognate subjects as may be required by the committee. In addition, the student must pursue independent investigation in some subdivision of the selected field and must present the result of his investigation in the form of a dissertation.

A student becomes an applicant for the doctorate when he has been admitted to the Horace H. Rackham School of Graduate Studies and has been accepted in a field of specialization. No assurance is given that he may become a candidate for the doctorate until he has given evidence of superior scholarship and ability as an original investigator.

There is no general course or credit requirement for the doctorate. In most areas a student must pass a comprehensive examination in his major field of specialization, which tests his knowledge in that field and in the supporting fields, before he will be recommended for candidacy for the doctorate. A special doctoral committee is appointed for each applicant to supervise the work of the student both as to election of courses and in preparation of the dissertation.

Each student must demonstrate reading competence in one professionally acceptable language, in addition to English, before he can be accepted as a candidate for the Ph.D. degree. The language will be chosen, in consultation with the student, by the department chairman or program chairman or his designated representative. French, German, Russian, or any other language acceptable to the department chairman or program chairman may be offered. Individual departments or programs may have requirements for more than reading competence or more than one language.

The requirement for demonstration of reading competence may be satisfied in any one of the following ways:

- 1a. By courses—French, German, or Russian 112 completed with a grade of B or better.
- 1b. By courses in various languages judged of equivalent difficulty by the Graduate School.
2. By reading examination administered by the Graduate School.
3. By reading examination administered by the department.
4. By the Graduate Foreign Language Examination (Educational Testing Service) in French or German only.

A pamphlet that describes the general procedure leading to the doctorate is available in the Graduate School office upon request.

The following courses are offered in conjunction with the above programs:

Department of Naval Architecture and Marine Engineering

| | | |
|------------------------------|--|----------------|
| 200 | Introduction to Practice | 3 |
| 201 | Form Calculations and Static Stability I | 3 |
| 300 | Form Calculations and Static Stability II | 2 |
| 310 | Structural Design I | 3 |
| 330 | Marine Machinery I | 3 |
| 331 | Marine Machinery II | 3 |
| 350 (Meteor.— Ocean. 350) | Ocean Engineering | 3 |
| 400 | Maritime Engineering Management | 2 |
| 401 | Small Craft Design | 2 |
| 402 | Small Commercial Vessel Design | 2 |
| 410 | Stress Analysis of Ship Structures | 2 |
| 420 | Resistance, Propulsion, and Propellers | 4 |
| 430 | Design of Marine Power Plants I | 3 |
| 431 | Design of Marine Power Plants II | 3 |
| 440 | Ship Dynamics | 3 |
| 446 | Theory of Ship Vibrations I | 3 |
| 470 | Ship Design I | 3 |
| 471 | Ship Design II | 2 |
| 472 | Structural Design II | 2 |
| 473 | Design of Marine Power Plants III | 3 |
| 490 | Directed Study, Research, and Special Problems I and II | To be arranged |
| 510 | Advanced Structural Design | To be arranged |
| 511 | Directed Research in Ship Structure | To be arranged |
| 520 | Advanced Ship Model Testing | 2–3 |
| 521 | Research in Ship Hydrodynamics | To be arranged |
| 525 | Naval Hydrodynamics I | 3 |
| 526 | Naval Hydrodynamics II | 3 |
| 530 | Theory of Ship Vibrations II | 2 |
| 571 | Advanced Ship Design I and II | To be arranged |
| 572 | Economics of Ship Design and Operation | 2 |
| 590 | Advanced Reading and Seminar in Marine Engineering I and II | To be arranged |
| 591 | Advanced Reading and Seminar in Naval Architecture I and II | To be arranged |
| 592 | Master's Thesis | 3 |
| 620 | Advanced Propeller Theory and Cavitation | 2 |
| 625 | Naval Hydrodynamics III | To be arranged |
| 630 | Nuclear Ship Propulsion | 3 |
| 900 | Doctoral Thesis I and II | To be arranged |

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Benford, Harry, BSE, Department Chairman and Professor of Naval Architecture and Marine Engineering

Bhattacharyya, Rameswar, Dr. Ing., Lecturer

Couch, Richard B., AE, Professor of Naval Architecture and Marine Engineering

D'Arcangelo, A. M., MSE, Professor of Naval Architecture and Marine Engineering

Kaldjian, Movses, Ph.D., Assistant Professor of Engineering Mechanics

Michelsen, Finn C., Ph.D., Professor of Naval Architecture and Marine Engineering and Director of Ship Hydrodynamics Laboratory

Moss, James, MSE, Lecturer and Assistant Director of Ship Hydrodynamics Laboratory

Nowacki, Horst, Dr.S., Associate Professor of Naval Architecture and Marine Engineering

Ogilvie, T. Francis, Ph.D., Associate Professor of Naval Architecture and Marine Engineering

Sharma, Som Deo, Dr. Ing., Lecturer

West, George L., Jr., BSE, Professor of Naval Architecture and Marine Engineering and Professor of Nuclear Engineering

Woodward, J. B., III, Ph.D., Professor of Naval Architecture and Marine Engineering

Yagle, Raymond A., MSE, Professor of Naval Architecture and Marine Engineering

To obtain further information, address all inquiries directly to:

(A) For undergraduate work:

Professor John B. Woodward, III

Department of Naval Architecture and Marine Engineering

West Engineering Building

Ann Arbor, Michigan 48104

(B) For graduate work:

Professor T. Francis Ogilvie

Department of Naval Architecture and Marine Engineering

West Engineering Building

Ann Arbor, Michigan 48104

UNIVERSITY OF NEW HAMPSHIRE
Durham, New Hampshire

Study and research in the application of engineering to ocean exploration and exploitation is centered in the Engineering Design and Analysis Laboratory (EDAL), which is sponsored by all of the engineering departments. Faculty and students in engineering join in engineering projects aimed at solving real problems in ocean science and technology and carry their developments through actual trials whenever possible. The Laboratory maintains cordial but informal relationships with several oceanographic institutions, both private and government operated, which permit staff and students to have open ocean experience as well as the use of model tank testing facilities.

The Laboratory occupies 2000 ft. of floor space in Kingsbury Hall in the College of Technology, including a pressure test facility, an instrumentation laboratory and a student shop. Students and staff have access to all of the University facilities such as the Computation Center, the Electron Microscope, the State Engineering Test Station equipment for materials analysis and testing, and a fully equipped machine shop.

The degree of Master of Science is offered by the Departments of Chemical, Civil, Electrical, and Mechanical Engineering. For the degree, at least 30 credits must be earned, including a minimum of eight credits in courses, not including thesis, numbered 800–898. Department requirements relative to the thesis vary. (See Graduate Catalogue.)

The following courses are offered in conjunction with the above degree programs:

Department of Chemical Engineering

| | | |
|-----------|--|-----|
| 813 | Introduction to Fluid Dynamics | 3 |
| 815 | Heat Transfer | 3 |
| 816 | Diffusive Mass Transfer | 3 |
| 823 | Advanced Chemical Engineering Thermodynamics | 3 |
| 895, 896* | Graduate Independent Study | 2–4 |
| 899* | Master's Thesis | 1–6 |

Department of Civil Engineering

| | | |
|-----------|----------------------------------|-----|
| 742 | Hydrology | 3 |
| 784 | Topics in Structural Engineering | 3 |
| 841–842 | Advanced Hydraulics | 3 |
| 863–864 | Soil Mechanics | 3 |
| 895, 896* | Civil Engineering Problems | 2–3 |
| 899* | Master's Thesis | 6–9 |

Department of Electrical Engineering

| | | |
|----------|---------------------------------|-----|
| 695* | Electrical Engineering Projects | 1–4 |
| 711 | Digital Systems | 4 |
| 741 | Fundamentals of Acoustics | 3 |
| 758 | Communication Systems | 4 |
| 781 | Instrumentation | 4 |
| 782 | Control Systems | 4 |
| 851–852 | Advanced Control Systems | 6 |
| 891–892* | Research | 6 |
| 899* | Master's Thesis | 6 |

Department of Mechanical Engineering

| | | |
|-----------|--------------------------------|-----|
| 671 | Naval Architecture I | 3 |
| 695, 696* | Mechanical Engineering Project | 1–3 |
| 736 | Analytical Fluid Dynamics | 3 |

*Projects, research or theses of the Engineering Design and Analysis Laboratory are structured to include undergraduate or graduate students who wish to participate in an ongoing project oriented toward ocean problems. Current efforts are in hyperbaric systems for diver-scientists, oceanographic telemetry, control systems for dynamic oceanographic instrumentation, buoy technology, manned submersible vehicles, bioengineering concerned with marine vertebrates.

Department of Mechanical Engineering—Continued

| | | |
|------------------------------|---|------|
| 746 | Control of Physical Systems | 3 |
| 772 | Naval Architecture II | 3 |
| 801 | Continuum Mechanics | 4 |
| 808 | Theoretical Aero/Hydro-Mechanics | 3 |
| 812 | Vibrations of Continuous Media | 4 |
| 829 | Theory of Plates and Shells | 4 |
| 897* | Master's Project | 4 |
| 899* | Master's Thesis | 6–10 |
| College of Technology | | |
| 601 | Statistical Methods in Engineering and Physical Science | 3 |
| 780 | Engineering Analysis | 2–3 |

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Chemical Engineering

Zimmerman, Oswald T., Ph.D., Professor and Chairman of Chemical Engineering

Gehrhardt, Henry M., Ph.D., Assistant Professor of Chemical Engineering

Department of Civil Engineering

Zoller, J. Harold, Ph.D., Professor and Chairman of Civil Engineering

Klotz, Louis H., Ph.D., Assistant Professor of Civil Engineering

Department of Electrical Engineering

Murdoch, Joseph E., Ph.D., Professor and Chairman of Electrical Engineering

Blanchard, Fletcher A., Jr., M.S., Professor of Electrical Engineering and Acting Director of

EDAL

Dalton, William L., M.S., Instructor of Electrical Engineering

Glanz, Filson H., Ph.D., Assistant Professor of Electrical Engineering

Melvin, Donald W., M.E., Associate Professor of Electrical Engineering

Pokoski, John L., Ph.D., Assistant Professor of Electrical Engineering

Skutt, H. Richard, Ph.D., Associate Professor of Electrical Engineering

Winn, Alden L., S.M., Professor of Electrical Engineering

Department of Mechanical Engineering

Corell, Robert W., Ph.D., Professor and Chairman of Mechanical Engineering

Allmendinger, E. Eugene, M.S., Associate Professor of Mechanical Engineering

Azzi, Victor D., D.Eng., Associate Professor of Mechanics

Hochgraf, Frederick G., M.S., Associate Professor of Materials Science

Savage, Godfrey H., Engr., Professor of Mechanical Engineering and Director of EDAL

Stolworthy, E. Howard, B.S., Professor of Mechanical Engineering and Executive Officer of

Office of Marine Science and Technology

Tart, Charles K., Ph.D., Professor of Mechanical Engineering

To obtain further information, address all inquiries directly to:

Office of Marine Science and Technology
Kingsbury Hall
University of New Hampshire
Durham, New Hampshire 03824

*Projects, research or theses of the Engineering Design and Analysis Laboratory are structured to include undergraduate or graduate students who wish to participate in an ongoing project oriented toward ocean problems. Current efforts are in hyperbaric systems for diver-scientists, oceanographic telemetry, control systems for dynamic oceanographic instrumentation, buoy technology, manned submersible vehicles, bioengineering concerned with marine vertebrates.

**THE MARITIME COLLEGE OF
THE STATE UNIVERSITY OF NEW YORK
Fort Schuyler, Bronx, New York**

The Engineering Wing (Tode Hall) of the new Science and Engineering Building accommodates the various laboratories of the college's Engineering Department. The analog computer laboratory is equipped with two fully expanded Electric Associates Inc. (EAI) TR-20 computers and one EAI 580. These machines and associated equipment are used by students to model and solve engineering problems involving calculus, differential equations, and advanced mathematics in real time terms.

The Electrical and Electronic Engineering Laboratory is provided with extensive instrumentation and equipment that permits the students to perform experiments in electronics, electrical circuits and machinery, both A.C. and D.C.

The Transport Processes Laboratory is a thermal and fluid mechanics facility. The equipment is used by students in performing experiments and study projects in subsonic and supersonic flow, machinery tests for compressible and incompressible media, conduction, convection and radiation.

The Marine Engineering Laboratory has an instrumented sixty-horsepower turbine power plant with its own 200 psi 10,000 pound per hour package steam generator. In addition, it has test equipment and instrumentation associated with diesels, gasoline engines, gas turbines, fuel cells, an air compressor and an air conditioner and refrigeration test facility.

The Systems and Controls laboratory has an Autodynamics Inc. model 500 control systems trainer as well as four test stations with air, gas, water, steam, and electrical; 60 and 400 cycle A.C. and D.C. systems available. The test stations are used to test and analyze various types of systems and control systems that can be temporarily installed for that purpose.

The Manufacture Processes Laboratory has lathes, milling machines, shapers, drill presses, welding booth facilities, metalizing and heat treating equipment. All of these facilities are used by the students as part of their educational and training requirements.

The Strength of Materials laboratory has extensive testing equipment including a 200,000 lb. universal testing machine, three (3) 60,000 lb. universal testing machine, two (2) 10,000 in lb. torsion machines, a warner-swasey vibration-fatigue machine, and assorted accessories.

The College's training vessel EMPIRE STATE IV has an 8500 SHP power plant which is extensively instrumented with equipment including a shaft torsionmeter, laboratory type pressure and temperature sensing devices, and fourteen (14) flowmeters that measure steam, water, gases, fuel oil and air. The instrumentation system is integrated so that basic design parameters, such as lbs. fuel per SHP hr. is in continuous readout.

The College's 600-foot pier provides docking space for the EMPIRE STATE IV. A boat shed adjacent to the pier is used to house and to launch and retrieve the small boats. A tidal gauge station is situated close to the pier.

The college offers three **Bachelor of Engineering** curricula at its main campus: **Marine Engineering, Naval Architecture, and Electrical Engineering**. The summer sea term provides for education and training aboard the college training vessel EMPIRE STATE IV.

Each curriculum is accredited and in addition registered for professional engineering licensure in the state of New York. This means students may take Parts I and II of the New York State Professional Engineers examination during their senior year; the U.S. Coast Guard Third Engineer's operating engineer's license examination; and, if acceptable to the U.S. Navy, they can obtain an Ensign's commission in the Naval Reserve upon graduation.

All three engineering curricula follow a common core of subjects for the first two full years—Mathematics, Physics, Chemistry, Humanities, Basic Engineering Sciences and operational courses.

The Marine Engineering curriculum in the last two years specializes in courses in Engineering Analysis, Solid Mechanics, Transport Processes, Electrical Engineering, Engineering Economics and Value, Design, Technical Naval Architecture, Controls, Nuclear and Modern concepts, and Humanities and/or socio-economic studies.

The Naval Architecture major studies in his last two years in the course areas of Ship Form and Stability, Ship Structure, Ship Resistance. Electrical Engineering, Vibrators, Propeller Design and

Ship Design. The Naval Architect also has additional courses in the humanities and/or socio-economic studies.

The Electrical Engineer in his junior and senior years will study the areas of Network Analysis, Electromagnetic Systems, Electronics, Random Processes, Communications Theory, Controls and Technical Naval Architecture. The EE student also studies humanities and/or socio-economic studies in each of his upperclass terms.

The College also offers an undergraduate program in marine sciences and training for seagoing officers which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Engineering

Foody, John J., P.E., J.D., Professor and Chairman of Engineering

Femenia, Jose, M.M.E., Assistant Professor of Engineering

Gleicher, Norman J., EIT, Assistant Professor of Engineering

Kramer, Aaron R., P.E., Associate Professor of Engineering

Mathieson, John, M.M.E., Assistant Professor of Engineering

McNeill, Joseph G., Sc.M., Associate Professor of Engineering

Pergament, Stuart P., M.S.E., Assistant Professor of Engineering

Thornton, James K. P.E., Assistant Professor of Engineering

Wennagel, Norman G., P.E., Professor of Engineering

Zubaly, Robert, M.S.M.E., Professor of Engineering

Ship's Staff

Pfleging, Edward F., B.S., Professor and Chief Engineer of Training Ship

Dreyer, Richard C., B.E. (Marine), Ship's Watch Officer and Assistant Instructor

Kuhl, William R., B.E. (Marine), Ship's Watch Officer and Assistant Instructor

O'Neill, John M., B.E., (Marine), Ship's Watch Officer and Assistant Instructor

Rowen, Alan J., (Marine), Ship's Watch Officer and Assistant Instructor

To obtain further information, address all inquiries directly to:

Dr. John J. Foody, P.E.

Professor and Chairman

Department of Engineering

State University of New York Maritime College

Fort Schuyler, Bronx, New York 10465

NEW YORK UNIVERSITY
University Heights, New York, New York

The School of Engineering and Science of New York University has expanded its program in Ocean Engineering. Options in Ocean Engineering are offered by five departments in programs that combine traditional engineering disciplines with environmental courses.

The following degrees are offered in the areas indicated.

1. M.S. in Aeronautics and Astronautics
2. M.S. in Chemical Engineering
3. M.S. in Civil Engineering
4. M.S. in Mechanical Engineering
5. M.S. in Metallurgy

Candidates electing the ocean engineering option will be required to attend an OCEAN ENGINEERING SEMINAR in which the contributions of the engineering sciences to the design and fabrication of equipment used over, on, or in the oceans will be studied.

The program is aimed at providing the latest and most pertinent information applicable to the solution of the engineering problems that arise in the design of objects used for the exploration, scientific study, and exploitation of the oceans. The program will be coordinated with courses concerning the oceans as an environment to be given by the Department of Meteorology and Oceanography.

The following courses are offered in conjunction with the above programs:

Aeronautics and Astronautics

Foundations of Hydrodynamics

Topics in Hydrodynamics

Chemical Engineering

Materials for Underseas Operations

Ocean Industrial Operations

Civil Engineering

Forces on Marine Structures

Marine Structures

Coastal Engineering

Mechanical Engineering

Environmental Engineering and Control in Confined Spaces

Design Analysis of Underwater Structures and Vessels

Metallurgy and Materials Science

High Pressure Effects in Metallurgy

Corrosion and Corrosion Control

Meteorology and Oceanography

Transmission of Sound in Sea Water

Electromagnetic Properties of Sea Water

Oceanography and Space Technology

The University also offers undergraduate and graduate programs in marine sciences which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Aeronautics and Astronautics

Isom, Marris P., Ph.D., Associate Professor

Werner, Jack E., Ph.D., Associate Professor

Department of Chemical Engineering

Shaffer, Richard F., M.S., Adjunct Professor

Department of Civil Engineering

Gidlund, Erick R., Ph.D., Assistant Professor

Department of Electrical Engineering

Greenstein, Philip, M.S., Professor

Department of Mechanical Engineering

Mueller, Wheeler K., Jr., Ph.D., Professor

Department of Metallurgy and Materials Sciences

Cadoff, Irving B., Eng. Sc.D., Associate Professor

Margolin, Harold, D.Eng., Professor

Department of Meteorology and Oceanography

Pierson, Willard J., Jr., Ph.D., Professor (Chairman)

To obtain further information, address all inquiries directly to:

Office of Assistant Dean

Graduate Division

School of Engineering and Science

New York University

University Heights, New York, New York 10453

UNIVERSITY OF RHODE ISLAND
Kingston, Rhode Island

The shore facilities and ship facilities of the Graduate School of Oceanography are available to ocean engineering faculty and graduate students. In addition, the College of Engineering laboratories include a well-equipped soils and sediments laboratory, an underwater acoustics laboratory in a new building, a sub-critical reactor, many wave and model tanks in the several engineering buildings. Nearby Navy and industrial laboratories have made much of their facilities available for cooperative research work.

The following degrees are offered by the University:

1. Master of Science in Ocean Engineering.
2. Doctor of Philosophy in Ocean Engineering.

Many graduate engineering courses in the classic departments are available to ocean engineering majors and applicable to their programs of study. In addition to these, the following ocean engineering courses are offered.

| | |
|-------------------|--|
| OE 134 (ChE 134) | Corrosion and Corrosion Control |
| OE 201, 202 | Ocean Engineering Seminar |
| OE 203, 204 | Ocean Engineering Principles |
| OE 210 | Engineering Ocean Mechanics |
| OE 231 | Introduction to the Analysis of Oceanographic Data |
| OE 287 | Submarine Soil Mechanics |
| OE 291, 292 | Special Problems |
| OE 321 | Underwater Acoustics I |
| OE 322 | Underwater Acoustics II |
| OE 351, 352 | Advance Design |
| OE 391, 392 | Special Problems |
| OE 206 (ME 206) | Environmental Control in Ocean Engineering |
| OE 215 (Geol 215) | Coastal Engineering Geology |
| OE 264 (CE 264) | Marine Structural Design |
| OE 353, 354 | Ocean Engineering Systems Studies |

The University also offers undergraduate and graduate programs in marine sciences and an associate degree program in fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Middleton, F. H., Dr.Eng., Chairman and Professor
Brown, G.A., Sc.D., Professor
Nacci, V. A., M.S., Professor
Schenck, H. Van N., Jr., M.S., Professor
White, F. M., Jr., Ph.D., Professor
Haas, R. B., M.S., Associate Professor
Stanislao, J., M.S., Associate Professor
Rose, V. C., Ph.D., Assistant Professor
Soltz, G. C., Ph.D., Assistant Professor

To obtain further information, address all inquiries directly to:

F. H. Middleton, Chairman
Ocean Engineering Department
College of Engineering
University of Rhode Island
Kingston, Rhode Island 02881

STEVENS INSTITUTE OF TECHNOLOGY

Hoboken, New Jersey

The Davidson Laboratory is the center for research in ocean engineering at Stevens. The laboratory is staffed by 40 scientists and engineers and 55 support personnel engaged in more than 60 long-range research and development projects. The major facilities include: (1) a 130 ft. towing tank suitable for model studies of ships and other structures in regular and irregular seas; (2) a 75 ft. square basin for model tests on course stability and maneuvering characteristics of ships and submersibles; and (3) a 300 ft. towing tank for high speed testing; (4) an enclosed wind tunnel with 2½ ft. x 3½ ft. x 12 ft. test section and with a maximum wind speed capability of 200 ft/sec. Stevens has recently purchased and renovated a former luxury liner for use as a dormitory, permanently moored in the Hudson River immediately adjacent to the campus. A small oceanographic laboratory is being established aboard this ship.

The following degrees are offered in ocean engineering:

1. **Master of Engineering (Ocean).** The following courses are required of all students: OE 101-102, OE 103, OE 200, OE 201, and OE 203. The remaining credits required for the Master of Engineering (Ocean) degree can be earned by taking 15 credits of additional course work in a particular area of concentration or by taking 10 credits of course work and writing a master's thesis. Potential doctoral candidates are encouraged to select the thesis option in order to gain experience for the doctoral dissertation by first planning, organizing, performing, and reporting on a research problem of considerably less scope than that expected for the dissertation research.

2. **Doctor of Philosophy.** The program leading to the Doctor of Philosophy degree is designed to develop the student's capability to perform basic research or high level design in ocean engineering. All students entering the doctoral program must have a master's degree or equivalent. Students who have not earned their master's degrees in the Department of Ocean Engineering must take all of the courses required for the Master of Engineering (Ocean) degree or must have satisfactorily completed comparable courses in other institutions. In addition to having completed the above requirements, all doctoral candidates must pass the qualifying examination which includes not only an oral examination to test the student's capability for advanced study, but also an evaluation of his ability to write effectively. The student may demonstrate his writing ability by presenting either an acceptable master's thesis or a critical review of several technical articles dealing with some aspect of ocean engineering. Doctoral candidates are expected to concentrate their advanced graduate studies in one of the areas of specialization presently offered in the department: Free Structures in the Ocean, Fixed Structures in the Ocean, or Ocean Instrumentation. A fourth area of specialization, Pollution Control, is under development. Additional courses in the Departments of Electrical Engineering, Mathematics and Mechanical Engineering are to be taken by the student to complete his program.

Upon completion of his formal course work and before embarking on his dissertation research, the doctoral candidate must pass the preliminary oral examination and an examination in one foreign language in which pertinent literature is being published in the area of the student's research.

The following courses are offered in conjunction with the above programs:

| | | |
|--------|---------------------------------------|----|
| OE 101 | Descriptive Oceanography | 2½ |
| OE 102 | Descriptive Oceanography II | 2½ |
| OE 103 | Problems in Ocean Environments | 2½ |
| OE 104 | Ocean Instrumentation | 2½ |
| OE 125 | Principles of Naval Architecture I | 2½ |
| OE 126 | Principles of Naval Architecture II | 2½ |
| OE 127 | Laboratory in Naval Architecture | 2½ |
| OE 150 | Stochastic Marine Processes | 2½ |
| OE 200 | Fluid Dynamics for Ocean Engineering | 2½ |
| OE 201 | Theoretical and Applied Hydrodynamics | 2½ |
| OE 203 | Dynamic Oceanography I | 2½ |
| OE 204 | Dynamic Oceanography II | 2½ |
| OE 215 | Estuarine Oceanography | 2½ |

| | | |
|--------|--|-----|
| OE 220 | Dynamics of Ocean Waves | 2½ |
| OE 221 | Motion of Vessels in Waves | 2½ |
| OE 222 | Stability of Propelled and Towed Bodies | 2½ |
| OE 223 | Design of Marine Propulsors | 2½ |
| OE 224 | Hydrodynamics of High-Speed Marine Craft I | 2½ |
| OE 225 | Hydrodynamics of High-Speed Marine Craft II | 2½ |
| OE 230 | Buoy Design | 2½ |
| OE 231 | Vibrational Response of Ocean Structures | 2½ |
| OE 232 | Special Topics in Corrosion | 2½ |
| OE 233 | Soil Mechanics in Oceans and Estuaries | 2½ |
| OE 240 | Underwater Acoustics | 2½ |
| OE 241 | Instrumentation for Ocean Sensors | 2½ |
| OE 242 | Air-Sea Interactions: Theory and Measurement | 2½ |
| OE 243 | Special Topics in Ocean Instrumentation | 2½ |
| OE 250 | Optimal Control of Marine Systems | 2½ |
| OE 400 | Special Problems | 1-3 |
| OE 401 | Special Problems | 1-3 |
| OE 500 | Thesis in Ocean Engineering | 5 |
| OE 600 | Research in Ocean Engineering | |

The instructional staff for the courses listed above consists of the following:

Department of Ocean Engineering

Breslin, J. P., D.Sc., Chairman and Professor of Ocean Engineering
 Arase, Elizabeth M., Ph.D., Associate Professor of Ocean Engineering
 Arase, Tetsuo, Ph.D., Associate Professor of Ocean Engineering
 Savitsky, Daniel, M.S., Associate Professor of Ocean Engineering
 Hires, Richard I., Ph.D., Assistant Professor of Ocean Engineering
 Henry, Charles J., D.Sc., Research Associate Professor of Ocean Engineering
 Numata, Edward, M.S., Research Associate Professor of Ocean Engineering
 Strumpf, Albert, Ph.D., Research Associate Professor of Ocean Engineering
 Kim, Cheung Hun, Dr. Ing., Visiting Lecturer in Ocean Engineering

To obtain further information, address all inquiries directly to:

Dr. Richard I. Hires
 Department of Ocean Engineering
 Stevens Institute of Technology
 Castle Point Station
 Hoboken, New Jersey 07030

TEXAS A&M UNIVERSITY
College Station, Texas

Texas A&M University's Coastal and Ocean Engineering Laboratory has many facilities for research teaching. There is a 120-foot long, 3-foot deep and 2-foot wide two-dimensional wave tank in which mechanically and/or wind-generated wave phenomena may be investigated. Also, currents may be generated in either direction along the tank. As examples, the wave tank may be used to investigate waves generated by wind, storm tides, wave forces, beach scour, wave run-up, sediment transport and response of dynamic systems. A 150-foot long, 4-foot wide and 2-foot deep variable slope recirculating flume with a discharge capacity of 20 cfs is presently under construction. This facility may be used for sediment transport studies, boundary resistance, scour of submerged pipelines, etc.

A 179-foot University-owned research vessel operated by the Department of Oceanography is available to obtain ocean data and to provide instruction in ocean research techniques. The University owns an IBM 360-65-computer which is available for data reduction and analysis and the development of numerical and mathematical models. A 56-foot University-owned research vessel operated by the Civil Engineering Department is also available for work in bays and estuaries and on the Gulf of Mexico.

Texas A&M University offers the **Master of Science, Master of Engineering and Doctor of Philosophy degrees in Civil Engineering with a major in Coastal and Ocean Engineering.** The M.S. degree requires a thesis which should embody original work while the M.E. requires that the candidate write one or two reports on some aspect in his field of interest. The Coastal and Ocean Engineering graduate program is interdisciplinary in nature and flexible enough to satisfy the needs of individual students with a variety of backgrounds and a variety of career interests. Applicants with a bachelor's or master's degree in any area of science or engineering who can show evidence of ability to pursue graduate study in Coastal and Ocean Engineering are welcome to this program.

Typically, a student will take sufficient course work to establish a satisfactory background in Fluid Mechanics, Mathematics and Coastal and Ocean Engineering and then select further course work to suit his other interest from optional courses in Coastal and Ocean Engineering, Oceanography, Meteorology, Geology, Hydromechanics and Fluid Mechanics, Mathematics, Environmental Engineering, etc.

The following courses are offered in conjunction with the above programs:

Coastal and Ocean Engineering

| | | |
|-----------|---|-----|
| C. E. 675 | Coastal Engineering I | 3 |
| C. E. 677 | Coastal Engineering II | 3 |
| C. E. 676 | Ocean Engineering I | 3 |
| C. E. — | Marine Soils and Foundation Engineering | 3 |
| C. E. — | Ocean Structures Engineering | 3 |
| C. E. — | Coastal Sediment Processes | 3 |
| C. E. — | Estuary Hydrodynamics | 3 |
| C. E. — | Deep-Ocean and Continental Shelf Dredging | 3 |
| C. E. 685 | Problems | 1-3 |

Fluid Mechanics, Hydrology and Hydraulic Engineering

| | | |
|-----------|-----------------------------------|---|
| C. E. 462 | Hydromechanics | 3 |
| C. E. 463 | Hydrology | 3 |
| C. E. 458 | Hydraulic Engineering | 3 |
| C. E. 630 | Hydromechanics | 3 |
| C. E. 622 | Hydraulics of Drainage Structures | 2 |
| C. E. 627 | Hydrology | 3 |
| C. E. 628 | Hydraulic Engineering | 3 |
| C. E. 629 | Hydraulics of Open Channels | 3 |
| C. E. 631 | Theory of Fluid Mechanics Models | 2 |
| C. E. 674 | Flow Through Porous Media | 3 |

| | | |
|--|---|---|
| Oceanography | | |
| Ocean 608 | Physical Oceanography | 4 |
| Ocean 609 | Physical Oceanography | 3 |
| Ocean 612 | Elements of Ocean Wave Theory | 3 |
| Ocean 616 | Theory of Ocean Waves | 3 |
| Ocean 631 | Geological Oceanography | 3 |
| Meteorology | | |
| Met. 305 | General Meteorology | 3 |
| Met. 335 | Atmospheric Statics | 3 |
| Met. 336 | Atmospheric Dynamics and Kinematics | 3 |
| Geology | | |
| Geol. 315 | Principles of Sedimentation | 3 |
| Geol. 431 | Geomorphology | 3 |
| Geol. 620 | Geology of Ground Water | 3 |
| Geol. 625 | Advanced Ground Water Geology | 3 |
| Geol. 631 | Geology in Engineering Construction | 3 |
| Mathematics | | |
| Math 601 | Higher Mathematics for Engineers and Physicists | 4 |
| Math 602 | Higher Mathematics for Engineers and Physicists | 4 |
| Plus, any other math courses containing material applicable to Coastal and Ocean Engineering problems. | | |
| Institute of Statistics | | |
| Stat. 601 | Statistical Analysis | 4 |
| Stat. 604 | Special Problems in Statistical Computations and Analysis | 3 |
| Industrial Engineering—Computer Science | | |
| IE 458 | Programming of Digital Computers | 4 |
| IE 642 | Computer Methods in Applied Sciences | 4 |
| IE 646 | Computer Methods in Applied Sciences | 4 |
| Aerospace Engineering | | |
| Aero 320 | Numerical Methods | 3 |
| Aero 475 | Aerodynamics of Viscous Fluids | 3 |
| Aero 601 | Principles of Fluid Motion | 4 |
| Mechanical Engineering | | |
| M. E. 621 | Fluid Mechanics | 4 |

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Coastal and Ocean Engineering Division

Herbich, John B., Ph.D., Head and Professor of Civil Engineering
 Garrison, Clarence J., Ph.D., Assistant Professor of Civil Engineering
 Sorensen, Robert M., Ph.D., Assistant Professor of Civil Engineering

The following faculty members from other Divisions of the Civil Engineering Department and from various Departments of the University teach special courses in Coastal and Ocean Engineering and Oceanography and are generally concerned with the program.

Davis, William B., Sc.D., Associate Professor of Civil Engineering, Environmental Division
 Reid, Robert O., M.S., Professor of Oceanography and Civil Engineering
 Schiller, Robert E., Ph.D., Associate Professor of Civil Engineering, Hydraulics & Fluid Mechanics Division
 Cochrane, John D., M.S., Associate Professor of Oceanography
 Hann, Roy W., Ph.D., Associate Professor of Civil Engineering, Environmental Engineering
 Coyle, Harry M., Ph.D., Assistant Professor, Soil Mechanics Division
 Lowery, Lee L., Ph.D., Associate Professor of Civil Engineering, Structural Engineering Division
 Nowlin, Worth D., Jr., Ph.D., Assistant Professor, Oceanography Department

To obtain further information, address all inquiries directly to:
Mr. H. L. Heaton, Registrar
Texas A&M University
College Station, Texas 77843

THE UNIVERSITY OF TEXAS AT AUSTIN
Austin, Texas

The College of Engineering laboratories are well-equipped for Ocean Engineering research. Modern facilities and instrumentation are available for work in ocean hydrodynamics, structures, soils, saline water conversion, underwater acoustics and nuclear engineering. Numerous supporting laboratories are also available throughout the college. In addition, there are the facilities of The University of Texas Institute of Marine Science at Port Aransas which maintains a fleet of boats particularly suitable for ocean research in nearshore and estuarine waters.

The University offers the following degrees:

1. **Master of Science in Aerospace Engineering and Engineering Mechanics, Chemical, Civil, Electrical, Environmental Health, Mechanical, and Petroleum Engineering.** The program leading to the degree of Master of Science is not fixed but is developed in conferences between the student, the graduate faculty of the department in which the student elects to receive the degree, and a member of the Ocean Engineering Committee. Administrative procedures are handled through the graduate advisor of the department. The M.S. degree requires at least 30 semester hours of work beyond the B.S. degree, six hours of which are usually for a thesis. The specific requirements for the M.S. degree in each department may be found in the Graduate Catalog.

2. **Doctor of Philosophy.** The program leading to the degree of Doctor of Philosophy is worked out between the student, a member of the Ocean Engineering Committee and the departmental Committee on Graduate Studies. Students seeking this degree are expected to have well developed ideas about their goals in graduate study and to a large extent the Ph.D. program is adjusted to the student's interests consistent with general requirements of The University of Texas. The residence, foreign language, and other detailed requirements for the Ph.D. degree may be found in The University of Texas Graduate Catalog.

The Ocean Engineering Program at The University of Texas at Austin is interdisciplinary and combines a basic knowledge of the ocean with engineering specialties for the utilization of the resources of the sea and its boundary. The program is based on a number of core courses with the specific coastal and marine applications and supporting work with application to oceanic systems. Study in Ocean Engineering provides a balanced program including course work, individual study and research. By electing courses from across departmental lines individual programs can be set up in areas such as coastal and estuarine engineering, foundations and construction, mechanical and thermal systems, acoustics, communications and control systems, and ocean resources.

Courses in Ocean Engineering are offered during the regular year at the main campus of The University of Texas by the Departments of Aerospace and Engineering Mechanics, Chemical, Civil, Electrical, Mechanical, and Petroleum Engineering. Courses are also available at The University of Texas Institute of Marine Science at Port Aransas, Texas. A college-wide committee coordinates Ocean Engineering activities at The University of Texas and is available for advising students with their programs.

Department of Aerospace Engineering and Engineering Mechanics

Graduate Courses

| | |
|------------|------------------------|
| ASE 396.22 | Man-System Engineering |
| ASE 396.28 | Hydrodynamics |

Department of Chemical Engineering

Undergraduate Course

| | |
|---------|--|
| ChE 365 | Water Treatment Engineering: Corrosion |
|---------|--|

Graduate Course

| | |
|-----------|----------------------|
| ChE 381 M | Transport Operations |
|-----------|----------------------|

Department of Civil Engineering (Including Atmospheric Sciences and Environmental Health Engineering)

Undergraduate Course

| | |
|---------|-----------------------|
| MET 376 | Physical Oceanography |
|---------|-----------------------|

Graduate Courses

| | |
|------------|--|
| CE 397.22 | Special Studies in Ocean Engineering |
| CE 380K.3 | Functional Design of Coastal Structures |
| CE 380M.5 | Coastal Engineering |
| CE 397.24 | Estuarine Engineering |
| CE 394.1 | Interaction of Soils and Structures: Selected Problems |
| CE 394.2 | Interaction of Soils and Structures: Methods of Analysis |
| CE 396M.31 | Atmospheric Turbulence |
| CE 396M.32 | Atmospheric Boundary Layers |
| CE 396M.6 | Advanced Dynamic Meteorology |
| CE 397.54 | Streams and Estuaries |
| CE 397.52 | Marine Sciences for Engineers |
| CE 385L | Water Resources: Water Quality Improvement |

Department of Electrical Engineering**Undergraduate Course**

| | |
|------------|---------------------------------------|
| EE 379K.14 | Introduction to Engineering Acoustics |
|------------|---------------------------------------|

Graduate Courses

| | |
|-----------|--------------------------------------|
| EE 381J | Random Processes in Physical Systems |
| EE 384L.1 | Waves in Material Media |
| EE 397K.3 | Engineering Acoustics |

Department of Mechanical Engineering**Undergraduate Courses**

| | |
|---------|---|
| ME 379M | Introduction to Engineering Acoustics (Same as EE 397K.14) |
|---------|---|

Graduate Courses

| | |
|-----------|-----------------------------|
| ME 385Q.2 | Acoustical Field Theory |
| ME 385Q.3 | Ocean Sound Propagation |
| ME 389Q.2 | Design of Nuclear Systems |
| ME 397.40 | Oceanic Transport Phenomena |
| ME 389Q.4 | Similitude and Model Design |

Department of Petroleum Engineering

| | |
|----------|---|
| PE 383.6 | Rock Mechanics I |
| PE 383.8 | Rock Mechanics II |
| PE 383.4 | Offshore Drilling and Production Operations |
| PE 383.2 | Advanced Well Logging and Correlation |

The University also offers a graduate program in marine science which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Aerospace Engineering and Engineering Mechanics

Bertin, J. J., Ph.D., Assistant Professor
Konecci, E. B., Ph.D., Professor
Tapley, B. D., Ph.D., Professor and Chairman

Department of Chemical Engineering

Wissler, E. H., Ph.D., Chairman and Professor

Department of Civil Engineering

Cox, W. R., Ph.D., Assistant Professor
Eckenfelder, W. W., M.C.E., Professor
Fruh, E. G., Ph.D., Assistant Professor
Gloyna, E. F., Dr. of Engr., Professor and Director, Environmental Health Engineering
Labs., Director, Center for Research in Water Resources
Jehn, K. H., M.S., Associate Professor and Director, Atmospheric Science
Levine, J., Ph.D., Assistant Professor
Masch, F. D., Ph.D., Professor

Department of Civil Engineering—Continued

Matlock, H., M.S., Professor

Moore, W. L., Ph.D., Professor

Reese, L. C., Ph.D., Chairman and Professor

Wagner, N. K., Ph.D., Assistant Professor

Department of Electrical Engineering

Bostick, F. X., Ph.D., Associate Professor

Gregg, W. D., Ph.D., Assistant Professor

Hixson, E. L., Ph.D., Associate Professor

Smith, H. W., Ph.D., Professor

Straiton, A. W., Ph.D., Chairman and Professor

Department of Mechanical Engineering

Carter, W. J., Ph.D., Professor

Gage, S. J., Ph.D., Assistant Professor

Gruber, G. J., Ph.D., Assistant Professor

Helfinstine, R. A., Ph.D., Assistant Professor

Department of Petroleum Engineering

Coats, K. H., Ph.D., Associate Professor

Gray, K. E., Ph.D., Chairman and Professor

Jessen, F. W., Ph.D., Professor

Pirson, S. J., D.Sc., Professor

To obtain further information, address all inquiries directly to:

Professor Frank D. Masch

Department of Civil Engineering

The University of Texas at Austin

Austin, Texas 78712

UNIVERSITY OF WASHINGTON
Seattle, Washington

COLLEGE OF ENGINEERING. There are a number of laboratories throughout the College of Engineering which are used to support teaching and research in Ocean Engineering. A large Chemical Engineering Laboratory with special facilities such as a 20-foot glass distillation column, a 20-foot absorption column, and a fluid (air and water) loop for research and calibration is available. A hydraulics laboratory housed in a separate facility, a sanitation laboratory, and a structures laboratory are available in Civil Engineering. Electrical Engineering has the acoustics laboratory, the electronics and control systems laboratory, and the energy conversion laboratory. Mechanical Engineering has heat transfer and thermodynamics, experimental stress analysis, and material processing laboratory, and a vibrations and acoustics laboratory. A ceramics laboratory, a materials property laboratory and a minerals processing laboratory are available through Mining, Metallurgy and Ceramics. Nuclear Engineering has a separate teaching and research nuclear reactor (100 KW argonaut type) housed in a separate facility. Outstanding collections of books and periodicals of interest to engineers as well as a research computer laboratory round out the facility.

Students may specialize in Ocean Engineering at the B.S., M.S. or Ph.D. level by enrolling through any of the engineering departments in the College of Engineering. Theses at the M.S. and Ph.D. level are required in the field of Ocean Engineering. The addition and substitution of courses in oceanography, fisheries, atmospheric sciences, economics, etc., into the engineering program are presently arranged on an individual basis. Degrees are granted through the College of Engineering with a major in the appropriate engineering field.

The Division of Marine Resources acts as coordinator of the work being carried out in the marine-related sciences between the many Departments and Colleges of the University which are active in this field. These include Atmospheric Sciences, Botany, Chemical Engineering, Civil Engineering, Economics, Fisheries, Food Science, Forestry, Geography, Geophysics, International Business, Law, Mechanical Engineering, Oceanography, and Zoology.

The following courses are offered in conjunction with the degree programs (credits are in quarter hours). Basic engineering courses required for studies in Ocean Engineering from all the branches of engineering have not been listed. These may be obtained by reference to the University of Washington general catalog.

Civil Engineering

| | | | |
|----------|--|----------|------|
| 341 | Hydraulics | W | 3 |
| 350 | Sanitary Engineering | F, Sp | 3 |
| 457 | Instrumentation for Air and Water Analysis | W | 3 |
| 522 | Transportation Systems | F | 3 |
| 523 | Transportation Terminals | W | 3 |
| 542, 543 | Hydrodynamics I and II | F, W; Sp | 3, 3 |
| 544 | Coastal Hydraulics | Sp | 3 |
| 550, 551 | Sanitary Engineering Unit Operation I and II | W, W | 3, 3 |
| 553 | Advanced Sanitary Biology | W | 3 |
| 556 | Bioengineering Aspects of Waste Treatment | Sp | 3 |
| 557 | Water and Waste Water Treatment | Sp | 3 |
| 558 | Water Quality Management | W | 3 |
| 559 | Water Resource Management | F | 3 |

Mechanical Engineering

| | | | |
|---------------|--------------------|----------|---------|
| 490, 491, 492 | Naval Architecture | F, W, Sp | 3, 3, 3 |
|---------------|--------------------|----------|---------|

The University also offers undergraduate and graduate programs in marine sciences and fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Civil Engineering

Carlson, Dale A., Ph.D., Professor of Civil Engineering
Chenoweth, Harry H., M.S., Associate Professor of Civil Engineering
Christman, Russell F., Ph.D., Assistant Professor of Chemistry

Department of Civil Engineering—Continued

Ekse, Martin I., M.S., Professor of Civil Engineering
Hennes, Robert G., M.S., Professor and Chairman Civil Engineering
Mar, Brian W., Ph.D., Research Associate Professor of Civil Engineering
Nece, Ronald E., Sc.D., Professor of Civil Engineering
Richey, Eugene P., Ph.D., Associate Professor of Civil Engineering
Sylvester, Robert O., S.M., Professor of Civil Engineering
Welch, Eugene B., Ph.D., Assistant Professor of Applied Biology

Department of Chemical Engineering

Gardner, Howard S., Sc.D., Professor of Chemical Engineering and of Pulp and Paper Technology

Mechanical Engineering

Bartlett, Francis G., M.S.E., Associate Professor of General Engineering
Browne, Oscar M., Jr., M.S., Lecturer in Mechanical Engineering

Note: Faculty members in the College of Engineering teaching basic engineering courses required in the Ocean Engineering program are not listed but may be obtained by reference to the University of Washington general catalog.

To obtain further information, address all inquiries directly to:

Dr. Stanley R. Murphy
Director, Division of Marine Resources
University of Washington
Seattle, Washington 98105

WEBB INSTITUTE OF NAVAL ARCHITECTURE
Glen Cove, New York

Specialized facilities include a model basin, 93' x 10' x 5', with wavemaker, flow channel, Marine Engineering Laboratory which includes operating components of commonly encountered marine machinery, steam and diesel and time-sharing computer facilities.

Webb Institute offers the following degrees:

1. Bachelor of Science in Naval Architecture and Marine Engineering
2. Master of Science in Naval Architecture

The following courses are offered in conjunction with the above degrees:

| | |
|------------------------------------|--------------------------------|
| Practical Naval Architecture I | F |
| Practical Naval Architecture II | Sp |
| Ship Resistance and Propellers I | Sp |
| Ship Resistance and Propellers II | F |
| Theoretical Naval Architecture I | F |
| Theoretical Naval Architecture II | Sp |
| Theoretical Naval Architecture III | F |
| Ship Structures | Sp |
| Ship Design I & II | F, Sp |
| Marine Engineering I | Sp |
| Marine Engineering II | F |
| Marine Engineering III | F |
| Marine Engineering IV | Sp |
| Marine Engineering V | F |
| Marine Engineering VI | Sp |
| Fluid Mechanics II | Sp |
| Hydrodynamics II | Sp (of second year) |
| Advanced Structural Mechanics | F (of second year) |
| Advanced Structures I & II | Sp (of second and third years) |

The instructional staff for the courses listed above consists of the following:

Curran, Thomas M., M.E., Professor of Naval Architecture
 Lewis, Edward V., M.S., Research Professor of Naval Architecture
 Nevitt, Cedric R., S.M., Professor of Naval Architecture
 Holm, Jens T., M.S., Professor of Marine Engineering
 Hamlin, Norman A., S.M., Research Professor of Naval Architecture
 Ward, Lawrence W., D.Sc., Professor of Engineering
 Maclean, Walter M., D.Eng., Professor of Engineering
 Hoffman, Dan, B.Sc., Research Associate

To obtain further information, address all inquiries directly to:

W. A. Brockett, Rear Admiral, USN (Ret.)
 President
 Webb Institute of Naval Architecture
 Glen Cove, New York 11542

OTHER INSTITUTIONS OFFERING COURSES IN OCEAN ENGINEERING

University of Massachusetts

CURRICULA FOR MARITIME OFFICERS

CALIFORNIA MARITIME ACADEMY
Vallejo, California

The Academy is situated on a 67-acre campus adjacent to the Carquinez Straits. A deep water pier provides berthing space for the training ship GOLDEN BEAR and encloses a boat basin for power, sailing, and rowing boats.

An engineering building, Dwyer Hall, completed in 1961, provides office space for the Marine Engineering Department and classroom and laboratory facilities for instruction in chemistry, physics, electricity, electronics, diesel engines, machine shop and welding and burning.

The Federal Maritime Administration has provided the academy with a modern 7,040 ton, twin screw, turbo-electric drive, 16-knot vessel for the purpose of conducting the annual sea training period of approximately three months. The training ship GOLDEN BEAR is operated entirely by the midshipmen under the supervision of the Academy's licensed officer-instructors. The GOLDEN BEAR provides a modern training vessel for the actual performance of deck and engineering skills at sea. The ship is fitted with classrooms, a machine shop and the most modern equipment, including steam and diesel powered auxiliaries as well as turbo-electric propulsion. Reading and recreation rooms provide the necessary facilities for off-duty activities.

The Bachelor of Science degree in Nautical Science or the Bachelor of Science degree in Marine Engineering is conferred upon Midshipmen successfully completing the Academy program of instruction and the U.S. Coast Guard license examination.

The following courses are offered by the Departments indicated in conjunction with the above degrees:

Department of Nautical Science

| | |
|-----------|-----------------------------------|
| D-108 | Navigation |
| D-110 | Engineering Graphics |
| D-111 | Seamanship |
| D-112 | Rules of the Road |
| D-115-116 | Marlinspike Seamanship |
| D-117-118 | Boats |
| D-125-126 | Ship's Operations |
| D-201-202 | Navigation |
| D-205 | Physics I (Mechanics) |
| D-206 | Physics II (Electricity) |
| D-207 | Ship Construction |
| D-208 | Maritime Economics |
| D-210 | Ship Stability |
| D-212 | Rules of the Road |
| D-215-216 | Applied Seamanship |
| D-222 | Instruments and Navigational Aids |
| D-223 | Communications |
| D-225-226 | Ship's Operations |
| D-301-302 | Navigation |
| D-303 | Meteorology |
| D-304 | Maritime Law |
| D-305 | Radar |
| D-306 | Marine Rules and Regulations |
| D-308 | License Seminar |
| D-309-310 | Cargo I and II |
| D-311 | Seamanship |
| D-312 | Rules of the Road |
| D-323 | Communications |
| D-325-326 | Ship's Operations |

Department of Marine Engineering

| | |
|-----------|--------------------------------------|
| E-107-108 | Chemistry I |
| E-109 | Engineering Graphics |
| E-110 | Physics I |
| E-111 | Steam Engineering I |
| E-112 | Steam Engineering II |
| E-113 | Maritime Economic History |
| E-115-116 | Boats |
| E-118 | Machine Shop Lab |
| E-120 | Marine Machinery Laboratory I |
| E-208 | Machine Shop Theory |
| E-201-202 | Steam Engineering III-IV |
| E-203-204 | D-C and A-C Electrical Engineering |
| E-205 | Physics II |
| E-212 | Thermodynamics |
| E-216 | DC Electrical Laboratory |
| E-217 | Machine Shop Lab |
| E-218 | Marine Machinery Lab III |
| E-220 | Arc and Gas Welding |
| E-221 | Refrigeration and Air Conditioning |
| E-223 | Marine Machinery Lab II |
| E-301-302 | Steam Engineering V-VI |
| E-303-304 | Diesel Engineering |
| E-305 | Engineering Materials |
| E-306 | Ship Construction and Damage Control |
| E-307 | Automation Principles |
| E-308 | Electronics |
| E-310 | Nuclear Power |
| E-312 | Engineering Administration |
| E-314 | Labor Relations |
| E-315 | Diesel Laboratory |
| E-316 | Machinery Analysis Laboratory |
| E-317 | AC Electrical Laboratory |
| E-318 | License Seminar |
| E-319 | Marine Machinery Lab IV |
| E-320 | Marine Machinery Lab V |

The instructional staff for the courses listed above consists of the following:

Department of Nautical Science

Aguilar, CDR William H., B.S., CMA, Masters License unlimited, USNR (Ret.), Master Mariner, Head of Department

Heron, CDR Richard D., B.S., CMA, CDR USNR, Federal License: chief mate, steam and motor vessels, ocean, unlimited.

Taylor, LCDR Lyle, B.S., CMA, Federal license: third mate, steam and motor vessels ocean, unlimited.

Craig, LT Robert, B.S., CMA, Federal license: third mate, steam and motor vessels, ocean, unlimited.

Aschemeyer, LT Manfred H. K., B.S., CMA, Federal license: master, steam and motor vessels, ocean, unlimited.

Newton, LT Fred B., Jr., LCDR USN (Ret.), Federal license: master, steam and motor vessels, ocean, unlimited.

Wood, LT Philo, CDR USN (Ret.), A.B., Federal license: master, steam and motor vessels, ocean, unlimited.

Department of Marine Engineering

Bruhn, CDR Otto J., LT USNR, Federal license: chief engineer, steam vessels, ocean, unlimited, Head of Department.

Behm, LCDR Arthur S., Jr., B.S., CMA, LT USNR, Federal license: chief engineer, steam vessels, ocean, unlimited.

Beland, LT Thomas J., B.A., Federal license: second assistant engineer, steam vessels, ocean, unlimited.

Branin, LT Samuel W., B.A., LCDR USCG (Ret.), Federal license: chief engineer, steam vessels, ocean, unlimited.

LaBombard, LT Frank L., CHMACH W-4 USNR, Federal license: second assistant engineer, steam vessels, ocean, unlimited.

Thor, LT Howard A., Ph.D., LTJG, Federal license: first assistant engineer, steam, and third assistant engineer, motor vessels, ocean, unlimited.

Nilsen, LT Norman, B.S., third assistant engineer steam and motor, ocean, unlimited.

Barber, Mr. William, M.S.

To obtain further information, address all inquiries directly to:

Mr. Louis E. Kiger
Public Information Officer
California Maritime Academy
Box 1392
Vallejo, California 94590

MAINE MARITIME ACADEMY
Castine, Maine

Facilities include (1) the 10,000 ton steam training ship STATE OF MAINE, (2) the 85-foot training vessel PATHFINDER, (3) several yachts ranging in size from 50 feet to 27 feet, (4) several launches and work boats. The training vessels are equipped with all normal electronic navigation gear, such as radar, loran, fathometer, etc. The yachts and launches can be used for small parties and nearby activities. Castine is a deep-water harbor, accommodating ships of any size, and the Academy's wharves are adequate. The dock-side facilities include a machine shop, a forge and foundry, a rigging loft, an auxiliary steam plant, and a nuclear reactor.

The following degrees are offered:

1. B.S. in Marine Science
2. B.S. in Marine Engineering

The following courses are offered in conjunction with the above programs:

Nautical Science Department

| | |
|----------------|-----------------------------------|
| 102, 201, 202, | |
| 301, 302, | |
| 401, 402 | Piloting and Celestial Navigation |
| 201, 402 | Marine Meteorology |
| 201, 202, | |
| 302, 402 | Seamanship |
| 301, 302, | |
| 401, 402 | Rules of the Nautical Road |
| 402 | Maritime Rules and Regulations |

Marine Engineering Department

| | |
|---------------|--|
| 102 | Basic Nuclear Engineering |
| 202 | Nuclear Power |
| 301, 302 | Nuclear Propulsion and Reactor Operation |
| 201, 202, 402 | Marine Boilers |
| 401 | Thermodynamics |
| 401, 402 | Refrigeration |
| 302, 401, 402 | Diesel Engines |
| 302, 401, 402 | Turbines |

The instructional staff for the courses listed above consists of the following:

Nautical Science Department

Terry, Russel H., Master Mariner, Oceans, unlimited, Chairman, Professor of Navigation
McReel, William H., Chief Mate, Oceans, unlimited, Professor of Meteorology
Brown, Alfred A., Chief Mate, Oceans, unlimited, Associate Professor of Navigation
Hathaway, Louis S., Master Mariner, Oceans, unlimited, Instructor Nautical Science
Strautman, Robert E., Third Mate, Oceans, unlimited, Instructor Nautical Science

Engineering Department

Brown, Edward F., Chief Engineer, Steam, unlimited, Chairman, Professor of Marine Engineering
Creighton, Franklin W., Chief Engineer, Steam, unlimited, Instructor, Marine Engineering
Steam, unlimited
Markley, John P., Chief Engineer, Steam, unlimited, Instructor, Marine Engineering
Marks, Roger A., Second Assistant Engineer, Steam, unlimited, Instructor, Marine Engineering
Robinson, Charles S. L., M.S., Associate Professor, Nuclear Propulsion
Spinazola, Eugene H., Second Assistant Engineer, Steam & Diesel, unlimited, Nuclear Test Engineer, Instructor, Nuclear Propulsion
Wiles, James F., Chief Engineer, Steam, and Motor, unlimited Instructor, Marine Engineering

To obtain further information, address all inquiries directly to:

**Dr. A. S. Fairley, Academic Dean
Maine Maritime Academy**

Contact for Admission Information:

**Lt. David G. Buchanan, Director of Admissions
Maine Maritime Academy
Castine, Maine 04421**

**THE MARITIME COLLEGE OF
THE STATE UNIVERSITY OF NEW YORK
Fort Schuyler, Bronx, New York**

(For a complete description of the College's facilities, please refer to the College's listing in the **Marine Sciences** section of this publication.)

The students who successfully complete the courses required by this curriculum receive the degree of Bachelor of Science and, after passing the required U.S. Coast Guard examinations, a Federal license as Third Mate in the Merchant Marine. Registered as a general purpose degree, the Bachelor of Science degree for Marine Transportation majors satisfies all the requirements of the Court of Appeals for admission to law schools in New York State.

If acceptable in all respects, the graduate of this program can obtain a commission as Ensign in the U.S. Naval Reserve. The Maritime College has been fully accredited by the Middle States Association of Colleges and Secondary Schools since 1952.

Marine Transportation Department courses:

The Marine Transportation Department of the Maritime College offers courses in Nautical Science, Marine Navigation, Ocean Transportation, Maritime Law; and Economics—Principles, Geography, International Trade and Labor.

The course of study for students majoring in Marine Transportation includes the theoretical and practical education necessary to develop highly qualified licensed officers. It combines the humanities and sciences with nautical and marine transportation subjects to achieve a well-rounded collegiate program which will fully equip a young man to meet the present and future problems of life and the needs of the maritime industry, afloat and ashore. Theory and practice are integrated by relating the scholastic efforts of the academic year ashore to those of the S.S.T.P. aboard the college training ship during the summer months. (S.S.T.P.—Summer Sea Training Program.)

The Summer Sea Term (SST) is made up of two sessions of approximately equal duration. The third (sophomore) and second (junior) classmen are required to take one of the two assigned sessions in each of these periods. The first (senior) classmen are required to take both sessions in that one sea term. The summer voyages are required, credit bearing, staff supervised educational periods intended to insure necessary operational experiences for all cadets. In order to be graduated every student must successfully pass each of the three indicated summer periods on the college training vessel. The sea period grade is a report for a single course that is made up of several phases and requirements. Failure may result in repeating the period or disenrollment for inaptitude. Each succeeding period at sea will demand of the student the assumption of additional supervisory responsibilities and advanced operational knowledge. The first session starts the next day after the last day of scheduled final examinations of the spring term and ends about the middle of July. The second session starts the day after the arrival at Fort Schuyler of the training ship from the first session voyage, and ends on or about 1 September.

The objectives of the Summer Sea Training Term are accomplished by on-the-job training, by actual watch standing and ship work, and instruction through formal class periods which are designed to enhance the professional knowledge of the cadets. All phases of the program are conducted by experienced licensed officers and the cadets make use of the modern nautical equipment aboard the ship. Training aids are utilized when actual equipment is either not available or cannot be easily visualized.

Marine Transportation and Meteorology and Oceanography majors are rotated in a three-day cycle which includes one day each of watch, instruction, and ship maintenance. Within these phases each cadet receives training in the organization and management of a ship; ship maneuvering; navigation and meteorology; communications; and nautical rules of the road. All cadets are taught and exercised in abandon ship, fire and boat drills and ship safety, under simulated emergency conditions.

The Maritime College also offers undergraduate programs in marine science and ocean engineering which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Marine Transportation

De Simone, Guy J., Master Mariner, MBA., Chairman and Professor of Marine Transportation

Dutcher, Lester A., Master Mariner, MBA, Associate Professor of Marine Transportation

Farrar, Richard A., Ph.D., Assistant Professor of Economics

Frangol, Ramzi N., M.S., Lecturer in Labor Economics

Gallo, Francis X., Chief Mate-Oceans, B.S., Instructor of Marine Transportation

Hart, John C., J.D., Lecturer in Admiralty Law

Millington, Herbert, Ph.D., Professor of Economics

Mueller, Frank W., Graduate RCA Institute, Instructor of Marine Electronics

Nelson, Harold, Master Mariner, B.S., Ship's Officer & Instructor

Nolan, Gerard, Master Mariner; B.S., Executive Officer of Training Ship

Parnham, Harold A., Master Mariner, M.A., Associate Professor of Marine Transportation

Reynolds, Donald C., MBA, Lecturer in Economics

Sembler, William, Master Mariner, MBA, Professor of Marine Transportation

Van Wart, Donald W., Chief Mate (Unlimited), MBA, Associate Professor of Marine Transportation

To obtain further information, address all inquiries directly to:

Mr. Guy J. DeSimone, Chairman

Department of Marine Transportation

State University of New York Maritime College

Fort Schuyler, New York 10465

TEXAS MARITIME ACADEMY

Galveston, Texas

A campus is maintained in Galveston, Texas. The TEXAS CLIPPER, a 15,000 ton vessel (supplied by the Maritime Administration), is maintained and used as a training ship which makes annual cruises. The Naval Science Department administers prescribed naval subjects within academic standards set by the Chief of Naval Personnel. Each cadet who completes the naval science courses and is otherwise qualified becomes eligible for, and may be granted, an inactive commission as Ensign, U.S. Naval Reserve, upon graduation. The objectives of the Naval Science Department are to provide the cadet with a well-rounded course in basic naval subjects; to develop an understanding of naval science and a knowledge of naval practice; and to develop, by precept and example, the psychology and technique of leadership.

The following degrees are offered:

1. **B.S. in Marine Engineering**
2. **B.S. in Marine Transportation**

The following courses are offered in conjunction with the above degrees:

Department of Marine Engineering

| | |
|-----|---|
| 102 | Orientation |
| 200 | Basic Operations |
| 201 | Marine Engineering Mechanics |
| 203 | Engineering Laboratory |
| 204 | Engineering Laboratory |
| 300 | Intermediate Operations |
| 301 | Fluid Mechanics and Heat Transfer |
| 302 | Engineering Laboratory |
| 303 | Marine Thermodynamics |
| 304 | Marine Thermodynamics |
| 305 | Strength of Materials |
| 306 | Marine Refrigeration and Air Conditioning |
| 307 | Electrical Circuits |
| 308 | Electrical Machinery |
| 400 | Advanced Operations |
| 401 | Nuclear Propulsion I |
| 402 | Diesel Engineering |
| 403 | Marine Steam and Gas Turbines |
| 405 | Steam Generators |
| 406 | Engineering Repairs |
| 408 | Nuclear Propulsion II |
| 414 | Ship Automation |
| 415 | Nuclear Propulsion III |

Department of Marine Transportation and Nautical Science

| | |
|-----|----------------------------|
| 101 | Maritime Orientation |
| 301 | Ocean Transportation I |
| 302 | Marine Cargo Operations I |
| 304 | Ocean Transportation II |
| 402 | Ocean Transportation III |
| 406 | Marine Cargo Operations II |

Department of Nautical Science

| | |
|-----|--|
| 200 | Basic Communications, Navigation, and Seamanship |
| 201 | Naval Architecture I |
| 202 | Naval Architecture II |
| 203 | Seamanship I |
| 204 | Terrestrial Navigation |

Department of Nautical Science—Continued

| | |
|-----|---|
| 300 | Intermediate Communications, Navigation, and Seamanship |
| 301 | Seamanship II |
| 302 | Seamanship III |
| 303 | Celestial Navigation |
| 304 | Electronic Navigation |
| 400 | Advanced Communications, Navigation, and Seamanship |
| 401 | Seamanship IV |
| 404 | The Navigator |

Department of Naval Science

| | |
|-----|--------------------------------|
| 208 | Naval Orientation |
| 209 | Sea Power |
| 210 | Naval Weapons |
| 309 | Naval Machinery |
| 310 | Naval Operations |
| 311 | Navigation |
| 410 | Principles of Naval Leadership |

The instructional staff for the courses listed above consists of the following:

Department of Marine Engineering

Tormollan, Francis C., M.S., Head, Marine Engineering Department
Dahm, Ralph A., M.S., Marine Engineering and Science
French, David, B.S., Lecturer, Marine Engineering
Moore, John A., B.S., Lecturer, Nuclear Engineering
San Martin, Joseph G., B.S.E., Naval Architecture and Marine Engineering
Crosby, Gary A., B.S., Marine Engineering

Department of Marine Transportation and Nautical Science

Philbrick, Alfred R., Jr., B.S., Head, Department of Marine Transportation and Nautical Science
Armstrong, Robert W., B.S., Marine Transportation and Nautical Science
McMullen, William T., B.S., Marine Transportation and Nautical Science
Fleming, William R., B.S., Seamanship, Education

To obtain further information, address all inquiries directly to:

Milton H. Abelow
Business Manager
Bldg. 311, Fort Crockett
Galveston, Texas 77550

UNITED STATES MERCHANT MARINE ACADEMY

Kings Point, New York

The Academy's 39 buildings and marine facilities occupy 65 acres on the north shore of Long Island overlooking Long Island Sound, and include academic buildings, resident halls, shops and laboratories. The Academy operates miscellaneous small training craft on Long Island Sound.

All students, deck and engineering, are required to complete the full four-year prescribed curriculum, which includes general education courses as well as professional courses. Upon satisfactory completion of the prescribed curriculum and after passing the U.S. Coast Guard examination for a license as Third Mate or Third Assistant Engineer, all graduates receive the same degree, Bachelor of Science, and a commission as an Ensign in the United States Naval Reserve.

Two professional curricula are offered. The Department of Nautical Science offers a program for the preparation of deck officers, and the Department of Marine Engineering offers a program for the preparation of engineering officers. An experimental program, offered jointly by the two major departments, prepares midshipmen for "dual-licensing," that is, it provides midshipmen with training for service as both deck and engineering officers.

During the second year of studies, midshipmen are assigned to merchant ships for practical experience in the operation of ships and the development of the technical skills required of an officer. The general purpose of this period of sea duty is to familiarize midshipmen with the work done by ocean vessels and to indoctrinate them in the routines of ship's business as well as the duties performed afloat by officers and seamen.

Although the midshipman is expected to perform the prescribed studies on his own initiative, his progress in theoretical and practical work is checked at frequent intervals. Academy Training Representatives in New York, New Orleans and San Francisco assign midshipmen to different types of ships for varied experience, check and guide their progress, and maintain liaison between the Academy, steamship companies and the midshipmen. The Department of Shipboard Training coordinates and supervises the shipboard training of all midshipmen during their year at sea.

The following courses are offered in conjunction with the above programs:

Department of Nautical Science

| | | |
|------|------------------------------|----|
| D111 | Elements of Nautical Science | 2 |
| D112 | Elements of Nautical Science | 1½ |
| D101 | Safety of Life at Sea | 1½ |
| D102 | Safety of Life at Sea | 2 |
| D141 | Navigation | 2½ |
| D142 | Navigation | 4 |
| D443 | Navigation | 3 |
| D444 | Navigation | 4½ |
| D121 | Seamanship | 3 |
| D122 | Seamanship | 3 |
| D423 | Seamanship | 2½ |
| D424 | Seamanship | 2½ |
| D103 | Safety of Life at Sea | 2 |
| D104 | Safety of Life at Sea | 2 |
| D405 | Safety of Life at Sea | 2 |
| D406 | Safety of Life at Sea | 2 |
| D407 | Safety of Life at Sea | 2 |
| D125 | Seamanship Laboratory | 2 |
| D126 | Seamanship Laboratory | 1 |
| D127 | Seamanship Laboratory | 1½ |
| D428 | Seamanship Laboratory | 1 |
| D108 | Communications | 1 |
| D109 | Communications | 1 |
| D131 | Cargo | 3 |

Department of Nautical Science—Continued

| | | |
|--------|-------------------------|----|
| D432 | Cargo | 3 |
| D433 | Cargo | 3 |
| D451 | Electronics | 3 |
| D452-3 | Electronics | 6 |
| D455 | Gyro Compass Principles | 2 |
| D261 | Naval Architecture | 3 |
| D262 | Naval Architecture | 3 |
| D163 | Naval Architecture | 3 |
| D171 | Naval Architecture | 3 |
| D172 | Naval Architecture | 3 |
| D481 | Meteorology | 3½ |
| D482 | Astronomy | 3 |
| D483 | Oceanography | 3 |

Department of Engineering

| | | |
|--------|---|----|
| E101 | Engineering Graphics | 1 |
| E102 | Engineering Graphics | 1 |
| E103 | Engineering Graphics | 1½ |
| E104 | Engineering Graphics | 1 |
| E105 | Engineering Graphics | 1½ |
| E106 | Engineering Graphics | 1 |
| E111 | Basic Marine Engineering | 3 |
| E112 | Basic Marine Engineering | 2 |
| E113 | Elements of Marine Engineering | 3½ |
| E114 | Elements of Marine Engineering | 2½ |
| E115 | Elements of Marine Engineering | 2½ |
| E123-4 | Marine Machinery Repair | ¾ |
| E121-3 | Machine Shop | 5 |
| E233 | Statics | 3 |
| E234 | Dynamics | 4 |
| E235 | Hydraulics | 3½ |
| E236 | Strength of Materials | 4½ |
| E241 | Thermodynamics | 3 |
| E242 | Thermodynamics | 3¾ |
| E243 | Thermodynamics | 3¾ |
| E451 | Marine Engineering | 3¾ |
| E452 | Marine Engineering | 3¾ |
| E453 | Marine Engineering | 5½ |
| E461 | Electrical Engineering (Circuit Theory) | 3¾ |
| E462 | Electrical Engineering (Electrical Circuits and Machines) | 3¾ |
| E463 | Electrical Engineering (Electrical Machinery and Control) | 5½ |
| E471 | Internal Combustion Engines | 2¾ |
| E472 | Internal Combustion Engines | 3¾ |
| E473 | Marine Refrigeration and Air Conditioning | 5½ |
| E231 | Introduction to Engineering Science | 3 |
| E232 | Introduction to Engineering Science | 3 |
| E464 | Automatic Control Systems | 4½ |
| E465 | Electronics for Engineers | 3 |
| E454 | Marine and Industrial Water Analysis | 3 |
| E437 | Machine Design | 4 |

The instructional staff for the courses listed above consists of the following:

Department of Nautical Science

Hurder, Captain W. R., USMS (Marine License: Master), Professor and Head of Department
Fiore, Commander A. E., USMS; B.S. (Marine License: Chief Mate), Professor
Pearson, Commander L., USMS; M.S. (Marine License: Master), Associate Professor
LaDage, Lieutenant Commander J. H., USMS; B.A. (Marine License: Second Mate), Associate Professor
May, Lieutenant Commander R. B., USMS (Marine License: Second Mate), Associate Professor
Nazzaro, Lieutenant Commander P., USMS; M.A. (Marine License: Master), Associate Professor
O'Hara, Lieutenant Commander W. J., USMS (Marine License: Third Mate), Associate Professor
Steiner, Lieutenant Commander G. N., USMS (Marine License: Third Mate), Associate Professor
Thompson, Lieutenant Commander O. E., USMS; B.S. (Marine License: Chief Mate), Associate Professor
Wichert, Lieutenant Commander W. A. A., USMS; B.S. (Marine License: Second Mate), Associate Professor
Webster, Lieutenant E. N., USMS; A.A. (Marine License: Second Mate), Assistant Professor
Caines, Lieutenant C. F., USMS; B.S. (Marine License: Master), Assistant Professor
Sopher, Lieutenant (junior grade) J., USMS; M.E.(E), M.B.A., Instructor
Cooney, Chief Warrant Officer E. T., USMS, Laboratory Instructor
Browder, Chief Warrant Officer R. A., USMS, Laboratory Instructor

Department of Engineering

McCready, Captain L. S., USMS; M.M.E. (Marine License: First Engineer, Steam and Motor; Atomic Energy License: Sr. Reactor Operator; Professional Engineer (New York) License), Professor and Head of Department
Gross, Commander M. J., USMS; M.M.E. (Marine License: Chief Engineer; Professional Engineer (New York) License), Professor and Assistant Head of Department
Travis, Captain H. O., Jr., USMS; B.M.E. (Marine License: Chief Engineer; Professional Engineer New York) License), Professor
Carlson, Commander S. O., USMS; M.M.E. (Marine License: Second Engineer; Professional Engineer (New York) License), Professor
Hirschkwitz, Commander M. W., USMS; M.M.E. (Marine License: Chief Engineer; Atomic Energy License: Reactor Operator; Professional (New York) License), Professor
Hubert, Commander C. I., USMS; M.S.E.E. (Professional Engineer (New York) License), Professor
Sandberg, Commander C. W., USMS; B.S.M.E. (Marine License: First Engineer; Atomic Energy License; Reactor Operator), Professor
Drucker, Lieutenant J. H., USMS; M.E., M.S. (Marine License: First Engineer; Professional Engineer (New York and New Jersey) License), Associate Professor
Armstrong, Lieutenant Commander W. J., USMS (Marine License: First Engineer), Associate Professor
Barnes, Lieutenant Commander G. H., USMS; B.S. (Marine License: First Engineer), Associate Professor
Ferenczy, Lieutenant Commander E. D., USMS (Marine License: Chief Engineer), Associate Professor
Kirby, Lieutenant Commander H. M., USMS; M.A., Associate Professor
Schuler, Lieutenant Commander F. X., USMS; B.S. (Marine License: Second Engineer), Associate Professor

Department of Engineering—Continued

Wells, Lieutenant Commander R. B., USMS; B.S. (Marine License: Chief Engineer), Associate Professor

Kane, Lieutenant L. B., USMS; B.M.E. (Marine License: Third Officer), Assistant Professor

Kingsley, Lieutenant G. D., USMS (Marine License: Chief Engineer), Assistant Professor

McDonald, Lieutenant W. H., USMS; M.S., Assistant Professor

Panuska, Lieutenant R. C., USMS; A.B., Assistant Professor

Reynolds, Lieutenant F. X., USMS; B.S., B.S.M.E. (Marine License: Second Engineer; Professional Engineer (New York) License), Assistant Professor

Giaquinto, Lieutenant (junior grade) J. A., USMS, Instructor

Antell, Lieutenant (junior grade) J., USMS, Laboratory Instructor

Malinoski, Lieutenant (junior grade) L. A., USMS, Laboratory Instructor

Maroney, Lieutenant (junior grade) N. J., USMS (License: Journeyman Electrician), Laboratory Instructor

Newman, Lieutenant (junior grade) H. J., USMS (License: Certified Welder), Laboratory Instructor

Sferazo, Lieutenant (junior grade) L. J., USMS (License: Certified Welder), Laboratory Instructor

Smith, Lieutenant (junior grade) F. H., USMS, Laboratory Instructor

Department of Shipboard Training

Eisenberg, Captain R., USMS (Marine License: Master), Professor and Head of Department

Chicurel, Captain M. J., USMS; B.S. (Marine License: Master), Academy Training Representative, New York

O'Connell, Captain R. H., USMS; A.B., Academy Training Representative, San Francisco

Knutsen, Captain E. L., USMS; B.S. (Marine License: Master), Academy Training Representative, New Orleans

Boyle, Lieutenant Commander D. E., USMS; B.S. (Marine License: Master), Shipboard Training Assistant (Deck)

Chronowski, Lieutenant (junior grade) R. A., USMS; B.S. (Marine License: Second Engineer), Shipboard Training Assistant (Engine)

To obtain further information, address all inquiries directly to:

Assistant Dean

United States Merchant Marine Academy

Kings Point, New York 11024

CURRICULA IN FISHERIES

240 / 241

HUMBOLDT STATE COLLEGE

Arcata, California

The marine science programs at Humboldt State College offer instruction and opportunities for research in marine fisheries, oceanography, and the marine aspects of zoology, botany and ecology. Present facilities include saltwater aquaria, a water chemistry laboratory, ichthyology laboratories, and zoology and botany classrooms and laboratories. A 40-foot research vessel equipped with standard oceanographic and biological instrumentation is available. A marine sciences laboratory with a modern saltwater system is located at Trinidad, California.

The College offers the following degrees through the Division indicated:

Division of Natural Resources

1. Bachelor of Science in Fisheries

- a. General Education—Required and elective courses to insure cultural breadth in the humanities, social sciences and English and speech.
- b. Lower division requirements: Biol. 3, Bot. 1, Chem. 10A-10B, 11; Math 15A; Nat. Res. 2, 40, Zool. 1, Physics 15A-15B.
- c. Upper division requirements: Zool. 101, 112, Bot. 140 or 145, Fish. 110A-110B-110C, Fish. 120A-120B or Ocn. 100, Fish 130 or 135, Fish. 150, Fish. 160, Fish. 195, and Fish. 198.
- d. Approved electives: A total of 25 units.
- e. Free electives to bring total units for the B.S. degree to 192.

2. Master of Science in Fisheries

- a. Prerequisites: Satisfactory undergraduate preparation in fisheries or zoology.
- b. Required courses: Fisheries 260, 290, 295, and 298.
- c. Approved upper division or graduate electives in related fields to bring total units beyond the bachelor's degree to 45.

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

Division of Natural Resources:

Fisheries Courses:

Upper Division Undergraduate Courses

| | | |
|------|--|-----|
| 100 | Introduction to Fishery Biology | 3 |
| 102 | Field Course in Fishery Biology | 3 |
| 110A | Ichthyology | 4 |
| 110B | Ichthyology | 3 |
| 110C | Ichthyology | 3 |
| 126 | Problems in Water Pollution Biology | 3 |
| 135 | Ecology of Marine Fishes | 4 |
| 150 | Introductory Fish Population Dynamics | 3 |
| 160 | Principles of Fishery Management | 3 |
| 170 | Fish Culture and Breeding | 3 |
| 175 | Commercial Fisheries | 3 |
| 180 | Techniques in Fishery Biology | 3 |
| 184 | Fisheries Instrumentation, Gear, and Methods | 2 |
| 195 | Field Problems in Fisheries | 1-4 |
| 198 | Senior Fisheries Seminar | 1 |

Graduate Courses

| | | |
|-----|---|-----|
| 240 | Early Life History of Fishes | 3 |
| 245 | Economically Important Invertebrates | 3 |
| 250 | Advanced Fish Population Dynamics | 3 |
| 260 | Advanced Principles of Fisheries Management | 4 |
| 290 | Thesis | 1-4 |
| 295 | Research Problems in Fisheries | 1-4 |
| 298 | Graduate Fisheries Seminar | 1 |

242/243

The College also offers undergraduate and graduate programs in marine sciences which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Division of Natural Resources

Allen, George H., Ph.D., Professor and Coordinator of Fisheries

Barnhart, Roger A., Ph.D., Adjunct Associate Professor and Unit Leader, California Cooperative Fishery Unit

Bryant, Charles F., Ph.D., Adjunct Assistant Professor and Assistant Unit Leader, California Cooperative Fishery Unit

Welsh, James P., Ph.D., Associate Professor of Fisheries

To obtain further information, address all inquiries directly to:

Dr. James A. Gast
Director, Marine Laboratory
Humboldt State College
Arcata, California 95521

UNIVERSITY OF NORTH DAKOTA

Grand Forks, North Dakota

On the main campus in Grand Forks are four laboratories for fishery biology and limnology teaching and research, a marine aquarium facility, and oceanography teaching laboratory. Related facilities on the campus include the Computer Center containing an IBM 360 system and libraries containing the major fisheries biology, limnology and oceanography journals. The Chester Fritz Library is a Depository Library for Federal Government publications. The University Biological Station at Devils Lake has facilities for limnological and fishery research and boats and equipment for small lake studies.

The University offers the B.S. degree in Fishery and Wildlife Management through the Department of Biology.

The requirements for this degree are 125 credits which should include all of the following courses:

| | | |
|-------------------------|--|----|
| Biology 163-164 | General Biology | 8 |
| Biology 332 | General Ecology | 4 |
| Biology 336 | Systematic Botany | 4 |
| Biology 341 | General Physiology | 4 |
| Biology 350 | Genetics | 3 |
| Biology 365 | Comparative Anatomy of Vertebrates | 4 |
| Biology 403 | Seminar | 1 |
| Biology 425 | Ichthyology | 3 |
| Biology 431 | Wildlife Management | 4 |
| Biology 433 | Limnology | 4 |
| Biology 438 | Fisheries Biology | 4 |
| Biology 480 | Biometry | 3 |
| Chemistry 111-112 | Principles of Inorganic and Analytical Chemistry | 8 |
| Chemistry 212 | Organic Chemistry | 5 |
| Geology 101 | General Geology | 4 |
| Geology 525 | Weathering and Soils | 4 |
| Mathematics 105 | Trigonometry | 2 |
| Mathematics 211 | Analytical Geometry and Calculus | 4 |
| Physics 203 | General Physics | 4 |
| Civil Engineering 213 | General Surveying | 3 |
| Economics 101 | Principles of Economics | 3 |
| Engineering Drawing 101 | Engineering Graphics | 2 |
| English 209 | Technical and Business Writing | 2 |
| Speech 101 | Fundamentals of Public Speaking | 3 |
| Language 101, 102, 201 | (any modern foreign language) | 12 |

In addition, attendance for 1 session at a field station or field work with a conservation agency is required.

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Biology

Duerr, Frederick G., Ph.D., Associate Professor of Biology; Invertebrate Zoology and Physiology

Neel, Joe K., Ph.D., Professor of Biology, Director, Biological Station; Limnology

Owen, John B., Ph.D., Assistant Professor of Biology; Fisheries Biology

Department of Geology

Moore, Walter, Ph.D., Professor of Geology; Geophysics

To obtain further information, address all inquiries directly to:

Dr. Paul B. Kannowski, Chairman

Department of Biology

University of North Dakota

Grand Forks, North Dakota 58201

PENINSULA COLLEGE
Port Angeles, Washington

The fisheries building, completed in January, 1967, is an integrated unit comprised of one classroom, one lab-classroom, office for two instructors, an equipment room, museum, and workshop. A large covered area on one side furnishes shelter for boats, nets and other large equipment. Located on the campus is a 16' x 20' hatchery building capable of raising 250,000 fish to the fry stage. Two 15' circular cement ponds outside the building are used to hold fish until ready to plant. A small fishing boat, rehabilitated by the class, is also part of the equipment.

The degree of Associate of Applied Arts (Fisheries Certificate) is offered.

All students must receive passing grades in FISH 33, 34, 43, 44, 53 (Aquarium study), 54, 56, 72, 73, 74, 76 (Technical Report Writing), 80, 82 (Wildlife Management), 83, 90, 92, 93 (Fish and Game Regulations), 94 and GE91 (Surveying).

In addition to the above courses each student must complete one each of the fall, winter, and spring offerings of Fisheries Equipment—Hatchery Methods in any sequence, and have one year (or equivalent) of biological science. His college credits must total 90 credit hours.

The following courses are offered in conjunction with the above program. Those courses numbering 30-39 and 70-79 are offered in the fall quarter. Courses numbering 40-49 and 80-89 are offered in the winter quarter. Courses numbering 50-59 and 90-99 are offered in the spring quarter. (Credits are shown in quarter hours.)

| | | |
|---------|------------------------------------|---|
| Fish 33 | Fish Identification | 3 |
| Fish 34 | Commercial Fishing Methods | 3 |
| Fish 35 | Fisheries Equipment | 1 |
| Fish 43 | Life History of Fishes | 3 |
| Fish 44 | Marine and Freshwater Environments | 3 |
| Fish 45 | Fisheries Equipment | 1 |
| Fish 54 | Fish Tagging | 3 |
| Fish 55 | Fisheries Equipment | 1 |
| Fish 56 | Oceanographic Research Methods | 2 |
| Fish 72 | Fish Diseases | 3 |
| Fish 73 | Fish Farming | 2 |
| Fish 74 | Marine Mammals | 1 |
| Fish 75 | Fisheries Equipment | 2 |
| Fish 80 | Fisheries Statistics | 3 |
| Fish 83 | Fish Farming | 2 |
| Fish 85 | Fisheries Equipment | 2 |
| Fish 90 | Fisheries Statistics | 3 |
| Fish 91 | Aquatic Insects | 3 |
| Fish 92 | Marine Invertebrates | 3 |
| Fish 94 | Water Pollution | 3 |
| Fish 95 | Fisheries Equipment | 2 |

The instructional staff for the courses listed above consists of the following:

Fisheries Department

Mausolf, Robert G., B.S., Chairman, Fisheries Department, and Instructor

Well, Donald R., B.S., Fisheries Instructor

Grinols, Richard B., M.S., Fisheries Instructor

To obtain further information, address all inquiries directly to:

Registrar

Peninsula College

Port Angeles, Washington 98362

UNIVERSITY OF RHODE ISLAND
Kingston, Rhode Island
(Department of Fisheries & Marine Technology only)

The Department operates facilities both on and off the main campus at Kingston. Main operations are conducted from Wickford on Narragansett Bay where the training vessels are berthed. The facilities contain practical laboratories for training in Seamanship, Fishing Gear, Navigation, Electronic Aids (to navigation and fisheries), Engineering, and Electrical Technology. Two training vessels are available; the 47-foot GAIL ANN, specifically converted for fisheries training and completely equipped, with a Decca Navigator and Sonar, and capable of working all common fishing methods; and a 21-foot Romany Fisherman for in-shore training.

The Department offers the degree of Associate in Science (Commercial Fisheries). In order to obtain the degree, all students are required to complete 74 credits over a two-year period—45 in Fisheries and Marine Technology, 14 in General Education, and 15 in Business and Economics—and must satisfactorily complete eight weeks of field training aboard commercial fishing vessels between the first and second school years.

The following courses are offered by the Department in conjunction with the above program:

| | | | |
|----|-----------------------------------|----|---|
| 1 | Seamanship | F | 3 |
| 2 | Fishing Gear I | F | 5 |
| 3 | Fishing Gear II | F | 3 |
| 4 | Fishing Gear III | Sp | 4 |
| 5 | Marine Technology I | Sp | 4 |
| 6 | Marine Technology II | F | 4 |
| 7 | Navigation I | Sp | 4 |
| 8 | Navigation II | F | 3 |
| 9 | Biology and Conservation | Sp | 3 |
| 10 | Vessel and Construction Appraisal | F | 3 |
| 11 | Fishery Technology | F | 3 |
| 12 | Fisheries Hydrography | Sp | 4 |
| 20 | Fisheries Problems | Sp | 1 |

The University also offers graduate programs in marine science and ocean engineering which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Sainsbury, John C., Ph.D., Chairman and Associate Professor of Fisheries and Marine Technology

McCauley, James A., B.S., Assistant Professor of Fisheries and Marine Technology

Mead, Thomas L., Ph.D., Associate Professor of Fisheries and Marine Technology

Motte, Geoffrey A., Master Mariner, Assistant Professor of Fisheries and Marine Technology

Thomson, David B., Full Fishing Skipper, Assistant Professor of Fisheries and Marine Technology

To obtain further information, address all inquiries directly to:

Dr. J. C. Sainsbury, Chairman
Department of Fisheries & Marine Technology
210 Woodward Hall
University of Rhode Island
Kingston, Rhode Island 02881

UNIVERSITY OF WASHINGTON
Seattle, Washington

COLLEGE OF FISHERIES. The College of Fisheries is located on the University of Washington campus in the Fisheries Center Building. The Center houses classrooms, laboratories and general facilities as well as several research organizations.

The College has a collection of over 300,000 cataloged specimens of fishes for research and teaching purposes. It also has an experimental fish hatchery which developed and maintains the salmon run which is the basis for both instruction and research in the life cycle of Pacific salmon. A recirculating salt water aquarium is maintained for the study of the physiology and behavior of fish. There is, in addition, an extensive library of computer programs for processing biological data, and access to a Burroughs B5500 and an IBM 7040-7094 direct couple system.

The College of Fisheries field station at Big Beef Creek on Hood Canal provides additional opportunities for class field studies and research in stream and estuarine ecology. The Food Science facilities include separate well-equipped laboratories for food microbiology, food biochemistry and food analysis. A unique feature is the cobalt 60 research irradiator. A 67-foot diesel powered boat, operated by the College, is capable of trawling to a depth of 1,000 fathoms and is equipped for other types of fishing as well as a wide variety of experimental work.

The following degrees are offered in the College of Fisheries:

1. **Bachelor of Science in Fisheries (College of Fisheries—Fisheries Biology).** A student may major in fishery science or fishery management and administration. To do this he must take courses in Introductory Biology or Zoology, General Chemistry, English, College Algebra, Elements of Statistical Methods and Fisheries 101, 240, 311, 401, 456 and 495. In addition he must complete the required courses for his selected option.

2. **Bachelor of Science (College of Fisheries—Fisheries Biology).** An elective curriculum is available for students desiring a Bachelor of Science with a major in fisheries. The student must complete 36 credits in fisheries and sufficient electives to meet the University graduation requirements (as generally outlined for the above degree). This degree is specifically intended for students desiring a strong minor (minimum of 30 credit hours) in a related field. The choice of electives is subject to approval by the College.

Prospective students are invited to inquire about additional areas of emphasis in which undergraduate preparation may be made. Such areas include behavior, biometrics, economics and water pollution.

3. **Bachelor of Science (College of Fisheries—Food Science).** To obtain this degree in the food science program the student must complete the requirements for University graduation with at least ten hours in humanities and biological studies. Courses in biochemistry, chemistry, mathematics, physics, preventive medicine and Fisheries 380, 495 and Food Science 481, 482, 483, 484, 485, 487 and 498 are required.

4. **Master of Science (College of Fisheries).** Students must have a degree of bachelor of science in biological or physical science or fisheries or food science or the equivalent. At least one year of approved study with a completion of a research project and thesis leads to the Master's degree. A minimum of 45 upper division or graduate credits must be presented including 18 credits in Fisheries 700 or Food Science 700, six credits for Fisheries 520 or Food Science 521 and three additional credits in courses numbered 500 or above. Students must present a certificate of proficiency in one foreign language.

5. **Doctor of Philosophy (College of Fisheries).** Students must complete at least three years of graduate study including a dissertation. Credits earned for a Master's Degree may be applied toward the Doctor's degree. Students must present a certificate of proficiency in two foreign languages or in one foreign language with extended proficiency in translation.

The Division of Marine Resources acts as coordinator of the work being carried out in the marine-related sciences between the many Departments and Colleges of the University which are active in this field. These include Atmospheric Sciences, Botany, Chemical Engineering, Civil Engineering,

Economics, Fisheries, Food Science, Forestry, Geography, Geophysics, International Business, Law, Mechanical Engineering, Oceanography, and Zoology.

The following courses are offered in conjunction with the above programs (credits are in quarter hours).

Economics

535

Economics of Natural Resources

Sp

Fisheries

101

Introduction to Fisheries Science

F

5

240

Applications of Digital Computers to

Biological Problems

W

4

311

Biology of Fishes

F

3

314

Methods and Instruments for Fishery

Investigations

F, W, Sp

1, Max 3

379

Fisheries of the World

F

3

401

The Comparative Anatomy and Classifica-

tion of Fishes

F, Sp, Su

5

405

Economically Important Mollusca

F

5

406

Economically Important Crustacea

W

5

410

Zoogeography of Freshwater Fishes

3

425

Life History of Marine Fishes

W

5

451

Reproduction of Salmonoid Fishes

F

5

452

Nutrition and Care of Fishes

W

5

454

Communicable Diseases of Fishes

Sp

5

456

Principles of Management of Natural Resources

W

3

457

Principles of Management of Natural Resources

Sp

3

459

Aquatic Food Chains

W

5

460

Water Management and Pollution Studies

Sp

5

465

Problems in Fish Biology

Su

6

471

Principles of Aquatic Radioecology

F

3

472

Methods of Aquatic Radioecology

W

3

473

Radionuclides in the Aquatic Environments

Sp

3

495

Introduction to Fisheries and Food Science

Literature

F, W, Sp

2, Max 4

499

Undergraduate Research

F, W, Sp, Su

1-3, Max 9

501

On-the-job Training

F, W, Sp

1-3

(Max 3 for M.S., 9 for Ph.D.)

503

Systematic Ichthyology

W

5

504

Invertebrate Pathology

F

5

505

Research Techniques in Shellfish Biology

W

5

506

Shellfish Sanitation

Sp

5

507

Topics in Fish Ecology

F, W, Sp

1-5, Max 15

510

Fish Behavior

F

3

511

Fish Behavior Laboratory

F

2-3, Max 6

515

Fish Physiology

W

3

516

Fish Physiology Laboratory

W

2

520

Graduate Seminar

F, W, Sp

2, Max 6

530

Biological Problems in Water Pollution

W

3

531

Seminar in Water Pollution Problems

Sp

3

535

Metabolic Effects of Chemical Pollutants

Sp

4

540

Application of Digital Computers to

Problems in Aquatic Ecology

W

3

545

Speciation

W

3

Fisheries—Continued

| | | | |
|---------------------|--|--------------|----------|
| 556 | Introduction to Quantitative Population Dynamics | F | 5 |
| 557 | Theoretical Models of Exploited Animal Populations | W | 5 |
| 558 | Estimation of Population Parameters | Sp | 5 |
| 600 | Research | F, W, Sp, Su | * |
| 604 | Research (Max 3 for M.S., Max 10 for Ph.D.) | | * |
| 700 | Thesis | | * |
| Food Science | | | |
| 481 | Introduction to Food Technology | Sp | 5 |
| 482, 483 | Food Analysis I, II | F, W | 3, 3 |
| 484, 485 | Principles of Food Processing I, II | F, W, | 5, 5 |
| 486 | Deteriorative Processes in Foods | Sp | 5 |
| 487 | Food Analysis III | Sp | 3 |
| 504 | Principles of Technological Research in Food | F, W, Sp | 3, Max 6 |
| 521 | Graduate Seminar in Food Science | F, W, Sp | 1, Max 6 |
| Forestry | | | |
| 450 | Recreational Use of Wild Lands | W | 3 |
| 457 | Field Problems in Outdoor Recreation | W | 3 |
| 463 | Contemporary Problems in Forest Land Use | W | 3 |
| 476 | Pulp and Paper Technology | W | 3 |
| 477 | Pulp and Paper Laboratory | Sp | 3 |
| 481 | Pulp and Paper Unit Operations | Sp | 4 |
| 488 | Polymer Chemistry | Sp | 3 |
| 551 | Current Problems in Recreational Management of Wildlands | Sp | 3 |

The University also offers undergraduate and graduate programs in marine science and ocean engineering which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Economics

Crutchfield, James A., Jr., Ph.D., Professor of Economics

College of Fisheries

Beasley, Thomas M., Ph.D., Research Associate Professor of Radiochemistry

Bell, Milo C., B.S., Professor of Hydrology and Fish Guidance

Bevan, Donald E., Ph.D., Professor and Associate Dean

Bonham, Kelshaw, Ph.D., Research Professor in Radiation Biology

Brown, George W., Ph.D., Associate Professor of Biological Fisheries

Burgner, Robert L., Ph.D., Professor and Director, Fisheries Research Institute

Chapman, Douglas G., Ph.D., Professor

Chew, Kenneth K., Ph.D., Associate Professor, Shellfish Biology

DeLacy, Allan C., Ph.D., Professor of Marine Fish Ecology and Biology

Donaldson, Lauren R., Ph.D., Professor of Fish Biology

Hagen, Donald W., Ph.D., Assistant Professor and Curator of Fishes

Held, Edward, Ph.D., Research Professor in Radioecology

Jones, G. Ivor, Ph.D., Acting Associate Professor in Food Science and Gear Technology

Katz, Max, Ph.D., Research Professor in Water Pollution

Liston, John, Ph.D., Professor of Microbiology

Matches, Jack, Ph.D., Research Associate Professor in Microbiology

Mathisen, Ole A., Ph.D., Professor of Freshwater Ecology

Paulik, Gerald J., Ph.D., Professor of Population Dynamics

*The amount of credit is variable.

College of Fisheries—Continued

Olson, Sigurd M., Research Assistant Professor
Pigott, George M., Ph.D., Associate Professor in Food Engineering
Riddle, Victor M., Ph.D., Assistant Professor of Food Chemistry
Rogers, Donald E., Ph.D., Research Assistant Professor
Rothschild, Brian J., Ph.D., Associate Professor of Quantitative Ecology
Royce, William R., Ph.D., Professor and Associate Dean
Saddler, James B., Ph.D., Research Assistant Professor in Fish Physiology
Salo, Ernest O., Ph.D., Professor of Estuary Problems
Seymour, Allyn H., Ph.D., Professor and Director—Laboratory of Radiation Ecology
Smith, Lynwood S., Ph.D., Associate Professor of Fish Physiology
Sparks, Albert K., Ph.D., Professor of Shellfish Biology
Stober, Quentin J., Ph.D., Research Assistant Professor in Fisheries
Taub, Frieda B., Ph.D., Research Associate Professor in Ecology
Thorslund, Todd W., Sc.D., Assistant Professor
Van Cleve, Richard, Ph.D., Professor and Dean
Welander, Arthur D., Ph.D., Professor of Fish Taxonomy
Whitney, Richard R., Ph.D., Associate Professor

College of Forest Resources

Alian, G. G., Ph.D., Associate Professor of Fiber Science
Dowdle, Barney, Ph.D., Associate Professor of Forest Economics
Gardner, Howard S. (see Chemical Engineering)
Sharpe, G. W., Ph.D., Professor of Forest Recreation

To obtain further information, address all inquiries directly to:

Dr. Stanley R. Murphy
Director, Division of Marine Resources
University of Washington
Seattle, Washington 98105

OTHER INSTITUTIONS OFFERING COURSES IN FISHERIES

**University of Alaska
Cornell University
University of Hawaii
Louisiana State University (Baton Rouge)
University of Massachusetts
University of Miami
Northeastern University**

CURRICULA FOR MARINE TECHNICIANS

254/255

ANNE ARUNDEL COMMUNITY COLLEGE
Arnold, Maryland

The college occupied its new campus in 1967. At this time no special facilities are directly related to the program. However, marine instrumentation and ocean mechanics laboratories are planned for completion in 1970. Electrical and electronic laboratories and a computing center are currently available and utilized. The RIDGLEY WARFIELD, a modern catamaran oceanographic vessel operated by the Chesapeake Bay Institute, is being utilized on a lease basis for eight days afloat instruction and experience.

The College offers the Associate in Arts degree in Ocean Engineering Technology.

For the degree the student is required to take 45 total hours in Ocean Engineering Technology and related fields. The courses listed are required. In addition the student must complete 21-23 hours in general studies. In his second year he is required to take 3-4 hours of electives which may be chosen from the physical or biological sciences or the technologies.

Marine Science Courses Offered

| | | |
|---------|------------------------|---|
| OET 111 | Oceanography | 3 |
| OET 112 | Ocean Technology | 4 |
| OET 211 | Marine Instrumentation | 4 |
| OET 212 | Ocean Mechanics | 4 |

The instructional staff for the courses listed above consists of the following:

King, Richard D., M.A., Assistant Professor and Director of Ocean Engineering

To obtain further information, address all inquiries directly to:

Registrar

Anne Arundel Community College
Arnold, Maryland 21012

256 / 257

CAPE FEAR TECHNICAL INSTITUTE
Wilmington, North Carolina

Facilities at the CFTI consist of three well equipped laboratories for marine biology, chemistry, and physics and classroom area for instruction and demonstrations.

Operations at sea, in the Institute's own training ship, include practical seamanship, navigation, fishing operations, and necessary experiments, collection, and processing of the data in connection with marine biology and oceanography.

The Institute has recently acquired the 65-foot T-426 on a long-term loan basis for short one or two-day trips out of Wilmington as a teaching aid. However, from time to time the vessel will be used in research projects.

The School Ship ADVANCE II which has a length of 185 feet, a beam of 33 feet, and a draft of 11 feet, carries a twenty-six foot motor launch for oceanographic and hydrographic work and a Coast Guard approved whale boat for rescue training. The vessel's range is 2,500 miles at 15 knots. Accommodations for up to 70 students and instructors, in addition to the crew, are available. A small machine shop, pipe fitters shop, and electricians shop are also aboard. It is equipped with an Alden Facsimile capable of receiving weather and oceanographic information plus a program calculator.

Navigational equipment on the ship includes: 2 radar sets, 48 mile range; 3 PPI scopes; 4 Loran systems including A&C; 1 automatic direction finder; 1 portable direction finder; 2 marine radio-telephones; 4 radio receivers; 1 sub-signal sounding machine 200 fathoms maximum depth (300 fathoms white line recorder); 1 master gyro system with repeater peloruses.

Biological and fishing instruments and equipment used aboard the vessel include a number of trawls, seines, gill nets, plankton net, and dredges. Aboard ship, there is a biological laboratory for dissection, classification, and pickling of marine specimens; 2 brine tanks for freezing, chilling, and preservation of live specimens; a freezer for preservation of fish; and 2 double sectioned fish pens for icing of fish.

Oceanographic instruments and equipment on board the vessel include: 1 4 ton boom for heavy dredging; 2 BT winches, 600 feet cable each; 2 BT booms, adjustable; bathythermographs; acoustic current meters; current meters; oceanographic chemical laboratory for determination of salinity, oxygen, etc.; oceanographic sedimentation laboratory; separate office for processing of oceanographic data; 37-foot cabin cruiser with depth recorder for shallow water work; two 26-foot launches for inshore work; several small boats for inshore specimen collecting; and a biological laboratory with refrigeration facilities.

The Institute offers the **Associate in Applied Science degree in Marine Technology**.

The following courses are offered by the Marine Technology Department in conjunction with the AAS program:

| | |
|--------------------|-------------------------|
| 101 | Technical English |
| 102 | Technical English |
| 103 | Technical English |
| 204 | Technical English |
| 101 | Technical Math |
| 102 | Technical Math |
| 103 | Technical Math |
| 101 | Technical Physics |
| 102 | Technical Physics |
| 103 | Technical Physics |
| Marine Science 301 | Navigation & Seamanship |
| Marine Science 302 | Navigation & Seamanship |
| Marine Science 303 | Navigation & Seamanship |
| Marine Science 304 | Cartography |
| Marine Science 307 | Oceanography |
| Marine Science 308 | Oceanography |

| | |
|--------------------|--------------------------------|
| Marine Science 311 | Fishing Operations |
| Marine Science 312 | Fishing Operations |
| Mechanics 317 | Shipfitting & Maintenance |
| Mechanics 318 | Marine Auxiliary Equipment |
| PM 301 | Internal Combustion Engines |
| PM 302 | Marine Diesel Engines |
| Chem 301 | Chemistry |
| Chem 306 | Marine Chemistry |
| Biol 301 | Marine Biology |
| Biol 302 | Marine Biology |
| AHR 306 | Marine Refrigeration |
| | Typing and Calculator Practice |
| | General Ship Maintenance |

The instructional staff for the courses listed above consists of the following:

Jordan, Arthur W., Capt. School Ship ADVANCE II and Coordinator of Marine Technology Department, Instructor in Fishing Operations and Oceanography

Arseneault, Walter A., B.M.S., First Mate on School Ship, ADVANCE II and instructor in mathematics; Navigation and Seamanship, and Cartography

Gossen, Emmett J., Chief Engineer School Ship, ADVANCE II and Instructor in Internal Combustion Engines; Marine Diesel Engines; Marine Auxiliary Equipment, and Shipfitting and Maintenance

Sullivan, Brian T., B.S., Second Mate on School Ship, ADVANCE II

Williams, Robert H., First Engineer on School Ship, ADVANCE II and Instructor in Engines

Foss, Edward, Applied Oceanography

Goode, Robert, Marine Biology

Stanton, Michael, Fishing Gear Techniques

Sullivan, Robert, Mathematics

Doughty, Aftin, Licensed Instructor of Engineering

James, Richard, Licensed Instructor of Navigation

To obtain further information, address all inquiries directly to:

Capt. Arthur W. Jordan
 Coordinator, Marine Technology Department
 Cape Fear Technical Institute
 411 North Front Street
 Wilmington, North Carolina 28401

Mr. Clarence E. Dodgens
 Director of Student Personnel
 Cape Fear Technical Institute
 411 North Front Street
 Wilmington, North Carolina 28401

CLATSOP COMMUNITY COLLEGE
Astoria, Oregon

The College has complete laboratories for students of physics, chemistry, geology, botany, and zoology consisting of over 3,000 sq. ft. Modern shops for training of electronic technology provide 4,000 sq. ft.; precision machine work, 4,000 sq. ft.; welding, 5,000 sq. ft. Basic mechanics instruction areas are also available.

Clatsop College has its own 24-foot motor launch TRAINER I. On this, the students learn boat handling, seamanship, and pilotage. Additional shipboard activities include the making of plankton tows, Nansen casts, bottom sampling, etc., within the estuary and on the Columbia River.

The students are offered a minimum of 20 days a year aboard Oregon State University's vessels. The cruises are on the ocean for the purpose of scientific exploration and training in seamanship on an ocean-going vessel.

The Marine Technology courses are geared to training students in the field of scientific oceanographic exploration, and training as Laboratory Technicians both ashore and afloat. Through these courses they receive a thorough knowledge of boat handling, seamanship and maintenance of vessels through the 65-foot class.

The following degrees are offered:

1. Associate Degree in Marine Technology
2. Associate Degree in Oceanographic Technician
3. Associate Degree in Marine Electronics

The following courses are offered in conjunction with the above degrees:

| | | |
|-------|-------------------------------|---|
| 3.662 | General Oceanography I | 4 |
| 3.664 | General Oceanography II | 4 |
| 3.666 | General Oceanography III | 4 |
| 3.408 | Techniques in Oceanography I | 4 |
| 3.410 | Techniques in Oceanography II | 4 |
| 3.416 | Oceanography Field Problems I | 4 |
| 3.412 | Oceanography Instruments I | 3 |
| 3.500 | Seamanship I | 4 |
| 3.502 | Seamanship II | 4 |
| 3.504 | Seamanship III | 4 |
| 3.510 | Electrical Equipment | 2 |
| 3.512 | Marine Biology I | 4 |
| 3.514 | Marine Biology II | 4 |
| | Commercial Fishing Techniques | 4 |
| 3.524 | Boat Maintenance and Repair | 3 |
| 3.620 | Navigation | |

The instructional staff for the courses listed above consists of the following:

Elsbree, Jerrold S., Captain, Coordinator of Marine Technology Department, Master Mariner,
Associate Degree in Marine Technology

Kujala, Norman, M.S.

Bainer, Philip L., M.S.

Samuel, Warren R., Electronics

Johnston, Donald, Electronics

Schultz, Alfred, Welding

Mabry, Boyd, Certified Vocational Instructor

To obtain further information, address all inquiries directly to:

Capt. J. S. Elsbree
Marine Technology
Clatsop Community College
16th & Jerome
Astoria, Oregon 97103

FULLERTON JUNIOR COLLEGE
Fullerton, California

Standard laboratory facilities and classrooms, ship time donated to us by local institutions and government agencies, and visits to regional industrial facilities provide instructional situations.

The Fullerton Junior College program in Oceanographic Technician training is designed to prepare entry-level technicians in marine oriented operations. The curriculum grants the Associate in Arts degree, enabling students to transfer to senior institutions to pursue an academic rather than vocational-technical goal.

Basic oceanographic science and associated subjects are provided in campus facilities. Special equipment, research situations, ship management and "hands on" training require off-campus opportunities, frequently donated facilities.

In-year and summer experiences with on-board or on-shore work programs provide the student with actual on-the-job conditions and credit for up to eight units.

Continuous evaluation of student performances and objectives provides opportunity for limited specialty training in the physical or biological techniques in the marine sciences.

The following courses are offered in conjunction with the Oceanographic Technician Program:

| | | | |
|-------|---|-------|-------|
| 1 | General Biology | F, Sp | 5 |
| 25 | Marine Biology | Sp | 3 |
| 49ABC | Life Sciences Independent Study | F, Sp | 1-1-1 |
| 30 | Introduction to Ocean Science | F, Sp | 3 |
| 32A | Oceanographic Materials and Instruments | F | 3 |
| 32B | Oceanographic Materials and Instruments | Sp | 3 |
| 33 | Navigation-Drafting | Sp | 4 |
| 54 | Cooperative Oceanographic Technology | | 2-8 |
| A | Trigonometry and Elementary Functions | F, Sp | 5 |
| 1 | Physical Geology | F, Sp | 3 |
| 1L | Physical Geology Laboratory | F, Sp | 1 |
| 3 | Introduction to Chemistry | F, Sp | 5 |
| 2A | College Physics | F, Sp | 3 |
| 2B | College Physics | F, Sp | 3 |
| 3A | College Physics Laboratory | F, Sp | 1 |
| 3B | College Physics Laboratory | F, Sp | 1 |
| 1AB | General Zoology | F-Sp | 5-5 |
| 5AB | Principles of Biology | F-Sp | 4-4 |
| 81A | Technical Mathematics | F, Sp | 3 |
| 81B | Technical Mathematics | F, Sp | |
| 10 | Elementary Physics | F, Sp | 4 |

The instructional staff for the courses listed above consists of the following:

Brown, Martin D., Chairman, Division of Life Sciences

Craig, Howard, Coordinator and Instructor

Leyman, Larry, Instructor

To obtain further information, address all inquiries directly to:

Howard Craig, Coordinator
Oceanographic Technical Program
Fullerton Junior College
321 East Chapman Avenue
Fullerton, California 92634

HIGHLINE COMMUNITY COLLEGE Midway, Washington

The facilities on the campus are located in the Science and Engineering buildings. Classrooms and laboratories contain modern equipment. The college also maintains laboratory and dock facilities on Puget Sound for underwater training. These facilities are equipped to provide training in all types and phases of diving.

The Award of Certificate in Undersea Technology is offered.

The following courses are offered in conjunction with the above award:

| | | |
|---------------------|-------------------------------------|---------|
| Diving | | |
| 71-73 | Diving Fundamentals | 5, 7, 7 |
| 74 | Diving Applications | 5 |
| 75 | Marine Engines and Equipment | 3 |
| 81-83 | Advanced Diving | 7, 7, 7 |
| Engineering | | |
| 50 | Blueprint Reading | 3 |
| 60 | Engineering Fundamentals | 4 |
| 61-62 | Materials and Processes of Industry | 4, 4 |
| 82 | Construction Material | 3 |
| 121 | Surveying | 3 |
| Electronics | | |
| 51 | Basic Electronics | 3 |
| Math | | |
| 71 | Technical Mathematics | 3 |
| 72 | Technical Mathematics | 3 |
| Oceanography | | |
| 100 | Survey of Oceanography | 5 |
| Welding | | |
| 91-92 | Welding | 3, 2 |
| P.E. | | |
| | Life Saving | |
| English | | |
| 71-73 | Communications | 3, 3, 3 |

The instructional staff for the courses listed above consists of the following:

Elliott, Raymond S., Instructor, Welding
Hagen, Trond, B.S., Instructor, Civil Engineering
Powell, Roger B., M.A., Instructor, Engineering Technology
Sell, Phillip C., M.E.D., Department Chairman, Engineering Technology
Williams, Peter A., Instructor, Undersea Technology

Division of Natural Sciences

Chapman, D. Duane, Ph.D., Instructor, Oceanography
Livers, Joe J., Ph.D., Instructor, Mathematics
Neish, Gerald L., M.B.S., Instructor, Electronics

To obtain further information, address all inquiries directly to:

Mr. Peter Williams
Diving Instructor
Highline Community College
Midway, Washington 98031

Mr. F. Roger Smith
Assistant Dean, Occupational Programs
Highline Community College
Midway, Washington 98031

COLLEGE OF MARIN Kentfield, California

As a part of its Marine Technology Program, the college has a marine laboratory at Bolinas, California. The station is equipped with a circulating sea water laboratory and student living quarters. Vast mudflats and rich intertidal reefs provide excellent locales for biological studies. Two Boston Whalers and a 32-foot diesel oceanographic ship provide facilities for making nearshore water and sediment measurements. Cooperative in-service training is provided by oceanographic organizations in the San Francisco Bay Area.

The curriculum is designed so that introductory background courses in marine sciences are given in the first year. The summer at the marine station provides practical experiences. The second year involves specialized instruction in marine instrumentation and engineering courses. The graduate is certificated as a general marine technician and receives an Associate of Science Degree.

The student is required to take 48 total hours in the basic sciences and related fields. The courses required for the certificated program are marked by an asterisk (*). In addition the student must complete 13 hours in general studies. In his 4th semester he is required to take 6 hours of electives, and during his summer session he may elect two additional credits. The following courses are offered in Marine Technology:

First Year—Introductory foundation courses

1st Semester

| | | |
|---------------------|----------------------|---|
| *Biol 10 | General Biology | 3 |
| *Chem 11 | Elementary Chemistry | 4 |
| *Geol 1A | Physical Geology | 4 |
| *Math 50, 52, 53 | Elementary Algebra | 3 |

2nd Semester

| | | |
|-----------|--------------------------|---|
| *Biol 20A | Marine Biology | 3 |
| *Geol 20 | Oceanology | 3 |
| * | Computer Data Technology | 3 |
| *ET 70 | Basic Electronics | 3 |

Summer Session at the Bolinas Marine Station

| | | |
|-----------|-------------------------------------|---|
| *Biol 21A | Natural History of Marine Organisms | 3 |
|-----------|-------------------------------------|---|

Optional

| | | |
|-------------|----------------|-----|
| Biol 21B | Marine Ecology | 2 |
| Nat Hist 49 | Research | 1-3 |

Second Year—Specialized Physical Science Technician Training

3rd Semester

| | | |
|-----------|---------------------------|---|
| *Chem 71 | Chemistry Instrumentation | 4 |
| *Phys 55 | Elementary Physics | 4 |
| *ET 65A | Electronics Math | 3 |
| *Engr 51A | Geometric Drawing | 2 |

4th Semester

| | | |
|----------|----------------------------|---|
| *Phys 50 | Physics Instrumentation | 2 |
| *Phys 51 | Nuclear Instrumentation | 1 |
| *Engr 22 | Basic Engineering Graphics | 2 |
| MMT 59 | Machine Tool Processes | 2 |
| *NS 50 | Marine Technician Seminar | 1 |

Electives

| | |
|---------|-------------------------------|
| Biol 51 | General Microbiology |
| Geol 56 | Elementary Mineralogy |
| Engr 10 | Surveying |
| Art 48A | Basic Photographic Techniques |

The instructional staff for the courses listed above consists of the following:

Chan, Gordon L., M.A., Director of Marine Technology Program

Baver, David D., M.S., Oceanology

Bezirjian, Onnig H., Ph.D., Chemistry Instrumentation

Bruff, Stephen C., M.A., Geology

Greenfield, Donald R., M.A., Machine and Metals

Hansen, Michael P., B.S., Computer Data Technology

Howe, William W., M.S., Engineering Survey—Graphics

Johnson, Thos. C., M.A., Marine Photography

Martin, Donald W., M.A., Physics Instrumentation

Miller, Kenneth J., M.S., Mineralogy

Molina, Alfonso, M.A., Marine Biology

Petersen, Robert, M.S., Physics Instrumentation

Ridge, Russell M., M.A., Biology

Staley, James C., M.S., Electronics

To obtain further information, address all inquiries directly to:

Mr. Gordon L. Chan

Director, Marine Technology

College of Marin

Kentfield, California 94904

SANTA BARBARA CITY COLLEGE
Santa Barbara, California

The College offers a two-year training program for Marine Diving Technicians. The program was implemented in September, 1968, utilizing standard Physics, Geology, and improvised Marine Biology laboratories in addition to regular classrooms, welding shop and electronics laboratory. Basic Diving classes were conducted in a city-owned swimming pool with ocean dives from adjacent beach area and from A.C. Electronics research vessel SWAN. Advanced Diving classes will begin in the Spring of 1969 in special fiberglass tanks now being installed in an industrial facility rented by the College. Advanced ocean dives as well as practical experiments in Biological and Physical Oceanography will continue to be conducted from the SWAN. A complete machine shop facility is in the process of being established and will be available when required in September 1969. A new Life Science Building is now under construction. This building includes adequate laboratory facilities for Marine Biology, Biological Oceanography and Physical Oceanography.

The degree of A.S. in Marine Technology is offered by the Vocational-Technical Division. All students are required to complete a two-unit course in Hygiene and a three-unit course in American Institutions in addition to satisfactory completion of all course work listed below. Students must maintain a minimum grade point average of 2.0 ("C") in all courses in order to be eligible for the Associate in Science degree.

Courses used to make up the program for Marine Diving Technicians are offered by the following Divisions:

Life Science
Physical Science
Social Science
Business
Fine Arts
Vocational-Technical

The following courses are offered in conjunction with the above program:

| | | | |
|-------------------|--|-------|-----|
| English 18 | Technical Report Writing | | 3 |
| Speech 5 | Business Speech | | 3 |
| Biology 5 | Marine Biology | F, Sp | 3 |
| Biology 11 | Biological Oceanography | Sp | 4 |
| Geology 11 | Physical Oceanography | F | 4 |
| Physics 11-12 | Technical Physics | F, Sp | 8 |
| Economics 11 | Marine Law and Economics | Sp | 3 |
| Electronics 11 | Applications in Electronics | Sp | 3 |
| Electronics 41-42 | Technical Mathematics | | 6 |
| Marine Tech. 1 | Introduction to Marine Technology | F | 4 |
| Marine Tech. 2 | Basic Diving (SCUBA and HOOKAH) | F | 3 |
| Marine Tech. 3 | Advanced Diving | Sp | 3 |
| Marine Tech. 4 | Fundamentals of Marine Engines and Compressors | Sp | 3 |
| Marine Tech. 5 | Underwater Construction | F | 3 |
| Marine Tech. 6 | Underwater Operations | Sp | 3 |
| Marine Tech. 7 | Diver Tending | Sp | 3 |
| Marine Tech. 11 | Summer Work Experience | Su | 1-8 |
| Machine Shop 11 | Machine Shop Operations | F | 3 |
| Welding 1-2 | Oxy-Acetylene and Arc Welding | F, Sp | 4 |

The instructional staff for the courses listed above consists of the following:

Life Science Division

Profant, Robert J., Ph.D., Chairman and Professor of Biology
Jorgensen, William C., M.A.

Physical Science Division

Gray, Robert S., Ph.D., Instructor of Geology
Schuler, Frederic C., Ph.D., Instructor of Physics

Business Division

Halloran, Jack R., M. Ed., Assistant Professor of Business

Fine Arts Division

Hale, Helen G. (Mrs), M.A., Instructor of English and Speech

Vocational-Technical Division

Foxx, James E., M. Ed., Assistant Dean, Instruction, Vocational-Technical; Chairman of
Vocational Technical Division

Parker, Jim G., A.A., Instructor of Marine Diving Technology

Parks, H. Ramsey, A.A., Instructor of Marine Diving Technology; College Diving Officer

To obtain further information, address all inquiries directly to:

James E. Foxx
Assistant Dean, Instruction, Vocational-Technical
Santa Barbara City College
721 Cliff Drive
Santa Barbara, California 93105

SUFFOLK COUNTY COMMUNITY COLLEGE
Selden, L. I., New York

In addition to normal chemistry and biology laboratories, the following are used in teaching Marine Technology: a Sea Skiff 29-foot Cruiser, a Boston Whaler, a Special Marine Laboratory equipped with modern equipment, a 50 acre marine study area with two buildings, and the use of a Campus Computer Center.

The fundamental goal of the program is to provide qualified high school graduates with two years of coordinated technical and general education courses at the college level in order to enable them to function as technicians in marine and allied industries. A graduate of this program receives an **Associate in Applied Science Degree**, and is prepared to assume the duties of a marine technician.

The following courses are offered in conjunction with the above program:

| | | |
|----------|--------------------------------------|-----|
| MR 11 | Commercial Fishing Techniques | 2 |
| MR 22 | Navigation | 3 |
| MR 25 | Elements of Oceanography | 4 |
| MR 30 | Marine Ichthyology | 3 |
| MR 35 | Applied Microbiology | 3 |
| MR 40 | Commercial Marine Products | 3 |
| MR 45 | Elements of Marine Ecology | 4 |
| MR 50 | Shellfish | 4 |
| CH 25-26 | Marine Technology Chemistry I and II | 4-4 |
| BY 33-34 | Modern Biology I and II | 4-4 |
| DP 55 | Computer Programming-FORTRAN IV | 3 |

The following courses are offered for other students:

| | |
|-------|------------------------------|
| MB 21 | Marine Biology |
| OC 15 | Introduction to Oceanography |

The instructional staff for the courses listed above consists of the following:

Black, John A., B.A., Instructor
Hardy, C. Douglas, M.S.T., Assistant Professor
Kirchner, Carl, Ph.D., Professor
Sherrill, Edwin L., A.A., Technical Assistant
Smith, Walter L., M.S., Professor, Head of Department of Marine Science and Technology
White, Harry H, Technical Assistant

To obtain further information, address all inquiries directly to:

Walter L. Smith, Professor
Head of the Department of
Marine Science & Technology
Suffolk County Community College
Selden, Long Island, New York 11784

TEXAS A&M UNIVERSITY, JAMES CONNALLY TECHNICAL INSTITUTE
Waco, Texas
 and
TEXAS A&M MARINE LABORATORY
Galveston, Texas

The facilities at Waco include:

1. James Connally Technical Institute has classroom and laboratory facilities for and currently offers accredited courses leading to an **Associates of Applied Science Degree in: Electronics Technology, Instrumentation Technology and Electro-Mechanical Technology.**
2. Other related vocational courses provide complete classroom and shop facilities for teaching welding and the maintenance of gasoline and diesel engines.
3. Classroom and laboratory facilities for support courses in physics, mathematics, communication skills, and chemistry are available.

Facilities at Galveston include:

1. Texas A&M Marine Laboratory (biology laboratories, marine shops, four classrooms).
2. R/V ALAMINOS—used part-time for training purposes.
3. Texas Maritime Academy (classrooms, navigation and radio equipment).
4. TEXAS CLIPPER (15,000 ton training ship—used for life boat launching, winch operations and static displays).

Students completing a one-year program will receive a certificate of completion.*

Courses in Marine Science are offered by the Ocean Technician Training Department at Marine Laboratory, Galveston, a subsidiary reporting to James Connally Technical Institute (part of the Texas A&M University System).

The following courses are offered in conjunction with the Institute's program:

Oceanographic Instrument Technician:

| | | |
|--------------|--|---|
| OT-100 | Occupational Orientation (Oceanography) | 2 |
| ELT-175 | Shop Project (Marine oriented) | 1 |
| PHY-120 | Applied Physics I | 4 |
| ELT-180 | Instruments and Measurements | 4 |
| ELT-185 | Electronic Devices (Marine oriented) | 4 |
| PHY-121 | Applied Physics II | 3 |
| INT-261 | Measuring Principles I | 5 |
| INT-256 | Calibration and Standardization | 4 |
| CEM-157 | Hydraulics and Pneumatics | 3 |
| OT-102 | Descriptive Oceanography | 4 |
| Biol. 131.51 | Marine Organisms of Commerce | 3 |
| OT-105 | Principles of Navigation | 5 |
| OT-106 | Seamanship | 3 |
| OT-201 | Oceanographic Instrumentation | 5 |
| OT-202 | Navigation and Radio | 3 |
| OT-210 | Oceanographic Instrumentation, Calibration and Maintenance | 6 |
| OT-211 | Oceanographic Data Reduction | 3 |

Deck and Fisheries Technician:

| | | |
|---------|---------------------------|---|
| OT-100 | Occupational Orientation | 2 |
| PHY-102 | Applied Physics I | 3 |
| CEM-157 | Hydraulics and Pneumatics | 3 |

*The A.S. in Oceanographic Instrument Technology and the A.S. in Deck and Fisheries Technology degrees are proposed to begin within the next two years and will be offered at Galveston.

Deck and Fisheries Technician—Continued:

| | | |
|--------------|---|---|
| CHT-122 | Chemistry of Metals I | 3 |
| OT-102 | Oceanography | 4 |
| Biol. 131.51 | Marine Organisms of Commerce | 3 |
| OT-105 | Principles of Navigation | 5 |
| OT-106 | Seamanship | 3 |
| OT-201 | Oceanographic Instrumentation | 5 |
| OT-202 | Navigation and Radio | 4 |
| OT-203 | Rope, Knots, Cable, Fishing Gear Selection and Maintenance | 4 |
| OT-205 | Fishing Technology, Economics and Maritime Law | 6 |

The instructional staff for the courses listed above consists of the following:

- a. JCTI Staff Members
 - Lovelace, Richard, B.A., Associate Professor, Instrumentation
 - Solomon, Charles, B.A., Electronics, Associate Professor, Electronics
 - Hurley, Steve, BBA
- b. Galveston Staff Members
 - Rowe, Henry A., M.A., Director, Ocean Technical Training
 - Hennigan, John E., Instructor, Oceanographic and Electronic Instrumentation
- c. A&M Marine Laboratory
 - Ray, Dr. Sammy M., Ph.D., Director, Marine Laboratory (part-time instructor in marine biology in this program)
- d. Texas Maritime Academy (part-time instructors in navigation and seamanship)
 - Philbrick, Alfred R., Jr., Master, Training Ship TEXAS CLIPPER, Head, Department of Marine Transportation Associate Professor
 - Fleming, William R., Assistant Professor, Department of Marine Transportation, Commandant of Midshipmen (acting)
 - Armstrong, Robert W., Assistant Professor, Department of Marine Transportation, Chief Officer, TEXAS CLIPPER
 - McMullen, William T., Assistant Professor, Department of Marine Transportation, Navigator, TEXAS CLIPPER
 - St. Cyr, Leon, Chief Master at Arms, TEXAS CLIPPER, Chief Boatswain's Mate, USN (Ret.)
- e. Bureau of Commercial Fisheries (part-time instructors), Fishing Technology, Gear Selection and Maintenance, Rigging, Knots
 - Harrington, David L., B.S., Marine Supervisor and Fishing Gear Research
 - Gislason, Sigvatur

To obtain further information, address all inquiries directly to
Captain H. A. Rowe, Director
Ocean Technical Training
Marine Laboratory
Texas A&M University
Building 311, Fort Crockett
Galveston, Texas 77550

APPENDIX A

Institutions Offering Limited Ocean-Oriented Courses

270/271

APPENDIX A

The following institutions offer less than fifteen semester hours or equivalent of ocean-oriented courses:

1. Allegheny College
Dr. Jonathan E. Helmreich
Dean of Instruction
Meadville, Pennsylvania 16335
2. Ball State University
Mr. Robert L. Carmin, Dean
College of Sciences and Humanities
Muncie, Indiana 47306
3. California State College, Dominguez Hills
Dr. Robert B. Fischer, Dean
School of Natural Sciences and Mathematics
100 East Victoria Street
Dominguez Hills, California 90247
4. Cerritos College
Mr. Jules M. Crane, Jr.
11110 East Alondra Boulevard
Norwalk, California 90650
5. Florida Presbyterian College
Mr. Irving G. Foster, Chairman
Division of Mathematics and the Natural Sciences
St. Petersburg, Florida 33733
6. Ohio Wesleyan University
W. K. Patton
Department of Zoology
Delaware, Ohio 43015
7. Rensselaer Polytechnic Institute
Professor Samuel Katz
Department of Geology
Troy, New York 12181
8. State University College
Director of Graduate Studies
Oneonta, New York 13820
9. Virginia Polytechnic Institute
Mr. Byron N. Cooper, Head
Department of Geological Sciences
Blacksburg, Virginia 24061

272/273